THURSDAY, FEBRUARY 14, 1878

MR. STANLEY

SIR SAMUEL BAKER spoke the truth on Thursday night last in St. James's Hall when he told Mr. Stanley that the Prince of Wales might be regarded as the spokesman of the nation when he addressed the great explorer in warm words of welcome and admiration. Not for many years has there been so much excitement in London as there was on Thursday in connection with the wild rumours on the state of affairs in the East; it seemed as if people could not possibly have a shred of attention to bestow on any other matter, but nearly two hours before the time at which the meeting of the Geographical Society was to commence the doors of St. James's Hall were besieged by an eager crowd; and many hundreds, if not thousands, had to be left out in the distribution of tickets. The welcome which Mr. Stanley received could not possibly have been more enthusiastic. In view of the many hard words that have been spoken of Mr. Stanley's conduct under certain trying circumstances, the sight on the platform of the stately figure and genial face of the venerable missionary and explorer, Dr. Moffat, father-in-law of Livingstone, was exceedingly gratifying, showing, as we think it did, that so humane and experienced an "African" as he does not consider that Mr. Stanley has greatly sinned.

That Mr. Stanley should be received with all the enthusiasm of hero-worship by the civilised world is just what might have been expected. It is seldom, however, that a hero receives the glory due to his heroism so promptly as Mr. Stanley has done, especially when that glory has been earned in the field of exploration. Hitherto it has only been through the tardy medium of a book that the public at home have learned of an explorer's work; but in Mr. Stanley's case we have been able to watch his progress step by step by means of the eagerly-looked-for letters he sent home from the heart of Africa, like spectators watching the progress of an assault against a hitherto impregnable stronghold. Thus when Stanley emerged once more into "the light of common day" the very first white man at Emboma into whose hands that memorable appeal for help came knew at once that one of the greatest deeds of all time had been accomplished.

The exact grade to be allotted to Mr. Stanley among the *dii majores* of explorers must be left to a future generation, but this we may be sure of that when the man and his work shall stand clearly out against the "azure of the past," when all the accidental circumstances that accompanied the ever-memorable journey shall have been forgotten, Mr. Stanley will take his place among the foremost of pioneer explorers, as one of the greatest benefactors to humanity and science. He, indeed, has shown that there is work in the world for many generations of men of science, and it will be long after the region has been opened up to commerce ere science will have obtained an adequate knowledge of its treasures.

Mr. Stanley has been termed "the Bismarck of African exploration;" as Bismarck has united into one great empire the fragmentary states of Germany, so has Stanley by the work he has accomplished united into one great whole the *disjecta membra* of African exploration. But the likeness between the two men extends further than this; in the one case as in the other there has been a well-defined purpose carried out by means of a clear and cool head, firm nerve, unflinching will, and (perhaps more important than all) an iron constitution.

What then has Mr. Stanley done to justify the enthusiasm with which he has been universally received by high and low, by learned and unlearned?

One of the most remarkable characteristics of his work is the unprecedented rapidity with which it was accomplished, considering the rich harvest of results. As he told his followers at Zanzibar he meant to do, he shot across the continent like an arrow. In two years and a half, with many zigzags and subsidiary explorations, Africa was crossed from Bagamoyo to the mouth of the Congo. The great work of the expedition, the exploration of the Lualaba from Nyangwe to the sea occupied only five months; looking at it in all its aspects, no explorer ever did so great a work in anything like the time.

For thousands of years has the Nile been a mystery which civilised humanity has never ceased to seek to penetrate; no other geographical problem, not even the pole itself, has had such a fascination for Europe. Many and many a life has been sacrificed in the attempt to find the source of the sacred stream, and it was in seeking this goal that Livingstone wandered away south to find "the fountains of Herodotus," only to find a grave on the marshy shore of Lake Bangweolo. The glory of virtually settling the problem has remained to Livingstone's discoverer and pupil, Stanley. In his march northwards from Ugogo to Lake Victoria Nyanza, the explorer came upon a river which flows into the south of that lake, the river Shimeeyu, about 350 miles long, which may be regarded as one of the most remote, if not the most remote, of the sources of the old Nile. Further, into the west side of the lake flows Speke's Kitangulé river, which Mr. Stanley has re-baptised the Alexandra Nile; this river the latter explored with much thoroughness while staying at the court of the gentle Rumanika. He found it to be a broad lake-river, giving off many lagoons, one of them Speke's Lake Windermere, and having its source in Speke's Lake Akanyaru (now the Alexandra Nyanza) which again has, Mr. Stanley believes, a river of considerable length flowing into its west side, and another coming from the south, having its origin on the east of Lake Tanganyika. Here then, no doubt, we have the ultimate sources of the Nile, which have been sought for since history began. Mr. Stanley, we believe, has virtually set the question at rest, though we are sure he will willingly share the credit of the discovery with Speke, whose geographical instinct was astonishing, and the essential accuracy of whose discoveries have been throughout confirmed by his successor.

For the first time we have, through Mr. Stanley's exploration, an approximately accurate idea of the outline and extent of Lake Victoria Nyanza. Any map of Africa published two years ago shows this lake in a triangular shape, with an offshoot in its north-east corner. Mr. Stanley has broadened it out into an irregular square, with a coast-line of about 1,000 miles in length, studded with islands, many of them inhabited, and its shores peopled by many different tribes.

The geography of the region between Victoria Nyanza and Albert Nyanza may now be plotted with considerable

fulness after the work of Mr. Stanley, who, however, was unable to carry out the plan of doing for the Albert what he did for the Victoria. Through one of the valleys which run north and south between the mountains of this region flows another tributary of the Alexandra Nyanza, and on Mount Gambaragara dwell those mysterious fair-skinned people that Speke heard of, but specimens of whom Mr. Stanley actually saw. About the time of Mr. Stanley's visit, we may remind the reader, Signor Gessi explored the Albert Lake, and we believe, to judge from his narrative, was unwittingly driven to its southern shore, about 1° S. lat. Quite recently, as we recorded at the time, Col. Mason has sailed round the lake, and reports it to be comparatively small and land-locked, with no important affluent other than the Victoria Nile.

On Lake Tanganyika Mr. Stanley completed the work of his predecessors. He circumnavigated the lake, and for the first time accurately plotted the outline of its southern part, adding considerably to our knowledge of the people and products of its shores. We have already spoken at some length of his examination of the Lukuga, which Cameron set down on the middle of the western shore as the long-sought-for outlet of the lake. Stanley examined the Lukuga with great care, and concludes that at present it is only a creek, but that as the waters of the lake are encroaching on the shore, either by the rise of the former or subsidence of the latter, the Lukuga will, in a very short time, actually become an outlet. What Mr. Stanley has told us of the lake and the surrounding region is well calculated to whet the curiosity of the geologist and physical geographer. We have already alluded to Mr. Stanley's theory of the past physical history of the region; but even if his knowledge of geology were adequate to the formation of an acceptable theory, he had scarcely time enough to collect the necessary data. Here, at any rate, is a splendid field for the geologists of the future.

Had Mr. Stanley returned home after his exploration of Tanganyika, or had the toss between himself and poor Pocock been "tails to go south" and leave the problem of the Lualaba unsolved, no one would have blamed him, and his work in the Nyanza region would have added very considerably to his previous reputation as an explorer. But his daring dash down the Lualaba is a *coup* that has immortalised him; it has done for him what the publication of "Pickwick" did for Dickens, it has compelled the world to admit that in his own line he is a genius of the first rank. Indeed we cannot but regard the spirit which animated Stanley at this crisis of his journey in Africa as a really heroic one. He himself happily and aptly expressed it in his address at St. James's Hall by quoting the words which Tennyson puts into the mouth of Ulysses, and which he applied to the position of himself and his followers when they were left by their Arab escort on the broad bosom of the Lualaba, at the very gate of the unknown region:—

"My mariners,
Souls that have toil'd, and wrought, and thought with me,—
. . . . Come, my friends,
'Tis not too late to seek a newer world.
Push off, and sitting well in order smite
The sounding furrows; for my purpose holds
To sail beyond the sunset, and the baths
Of all the western stars, until I die.
It may be that the gulfs will wash us down:
It may be we shall touch the Happy Isles
And see the great Achilles whom we knew.
Though much is taken, much abides; and tho'
We are not now that strength which in old days
Moved earth and heaven; that which we are, we are;
One equal temper of heroic hearts,
Made weak by time and fate, but strong in will
To strive, to seek, to find, and not to yield."

The mouth of the Congo has been known since the Portuguese, in the fifteenth century, began to creep down the African coast, and Tuckey, in the beginning of the present century, traced it about 150 miles to the lower cataracts. Its origin and course was one of the few, probably the greatest of remaining, mysteries in geography. Long ago the Pombeiros and other travellers came across streams inland from the Portuguese possessions in south-west Africa, which run northwards, and latterly Livingstone made known the great river Lualaba, which, however, against all evidence, he believed to be connected with the Nile. One of the principal streams known, at least since the time of the Pombeiros, is the Casai, a considerable river running northwards, and which some geographers maintained must be the upper course of the Congo. Others again maintained, and the reports of the natives seemed to confirm it, that in the region between Nyangwé on the Lualaba and the sea, was a great lake into which that and other rivers flowed, while some seemed to think that the Lualaba ran southwards, and probably ultimately flowed into Lake Chad. Livingstone, as we have said, thought the Lualaba belonged to the Nile, while Cameron was convinced it was the Upper Congo, but that it flowed almost straight westwards. The solution of the problem was a task well calculated to fascinate a man like Stanley, a task in which all his rare qualities as an explorer would be developed to the utmost, but a task for which he has proved himself easily equal. It is difficult, indeed, to see how the work could have been accomplished for generations except by a man of Stanley's character, and by the method adopted by him. In whatever light we regard this part of his recent work in Africa—whether as a mere exploit, or as a vast addition to geographical knowledge, or in the light of the great results that are likely to follow to civilisation, commerce, and science—it has scarcely, if ever, been surpassed in the history of geographical exploration. We have in previous numbers shown the magnitude and importance of this discovery. In the course of a few months, by the daring genius of one man, there has been thrown open to our knowledge a river of the first rank, watering a region of apparently exhaustless resources both for the man of science and the trader. It is about 3,000 miles long, has many large tributaries, themselves affording many hundred miles of navigable water; waters a basin of nearly a million square miles, and pours into the sea a volume estimated at 1,800,000 cubic feet per second. Such a piece of work is surely enough to immortalise a man.

Such, briefly, is the work accomplished in so short a space by the Commissioner of the *Telegraph* and the *Herald*, a work which he set about as a mere piece of business in connection with his calling of special correspondent, but for which Mr. Bennett had the insight to see he was unusually well adapted. A private business enterprise has thus accomplished what the much-instructed and

elaborately-equipped expeditions of learned societies have failed to do. It would be a pity were Mr. Stanley's exceptional aptitude for the work of exploration allowed to lie fallow. Even in the basin of the Congo much remains to be done, and we doubt if any great results will follow the Portuguese expedition which Mr. Stanley met at Loanda. There is also South America, the centre of which is now more unknown than Central Africa, and which awaits a pioneer like Stanley to show the way to the minute explorer and surveyor. It is stated that Mr Gordon Bennett contemplates equipping a polar expedition, so that we fear he thinks he has done enough for Africa. But whether or not Mr. Stanley again enters the field as an explorer, he has written his name in indelible letters alongside that of Livingstone, on the heart of Africa.

WAS GALILEO TORTURED?

Ist Galilei gefoltert worden? Eine kritische Studie. Von Emil Wohlwill. (Leipzig: Duncker and Humblot, 1877.)

THIS work treats with exhaustive thoroughness a question first raised about a century ago, as early, in fact, as advancing political liberty rendered its public discussion consistent with personal safety, and which has occupied scientific biographers pretty continuously since that time. The author's main object in reopening an issue, which the majority of recent authorities consider as settled in the negative, is to bring into due prominence the bearing on it of fresh evidence rendered accessible only within the last ten years. Up to 1867, though it was known that a detailed official record of Galileo's trial was preserved in the archives of the Inquisition, only a few isolated and questionable extracts from it had been made public. In that year, however, M. Henri de l'Epinois, by permission of the Papal authorities, published *in extenso* the most important of the documents contained in the trial-record. These, supplemented by still more recent corrections and additions, which it is unnecessary to particularise here, supplied a body of new evidence bearing more or less directly on the issue whether the Roman Inquisition, in its treatment of the great astronomer, had recourse in any degree to that test of physical endurance which formed a recognised part of its procedure as of that of contemporary secular courts in cases like his.

It was of course to be expected that in documents drawn up exclusively for the use of the Inquisition itself there would occur a number of technical expressions the exact meaning of which would be far from obvious to a reader unacquainted with the details of procedure in the holy office. This accordingly turns out to be the fact, and interposes no slight obstacle to the interpretation of the fresh evidence thus presented. Wohlwill, in order to overcome it, has put himself through an elaborate course of Inquisitional literature, studying minutely the fixed technical forms for conducting suits in the holy office laid down in manuals and instructions published for the guidance of its own officials. It is obvious how firm is the foundation thus to be secured in comparison with the precarious guessing which would otherwise be inevitable. The tasks both of preliminary inquiry and of subsequent application, have been performed with the utmost diligence, accuracy, and sagacity.

It would be impossible, within the limits of this notice, to enter upon the detailed arguments by which Wohlwill supports his views. All that can here be done is to state the chief results at which he arrives, together, where feasible, with some indication of the line by which he has travelled.

The final sentence delivered by the Inquisition in Galileo's case contains a statement that the court had judged it necessary to proceed against him to "the rigorous examination."[1] Libri had, as early as 1841, asserted, on the authority of various inquisitional manuals, and in particular of one entitled "Sacro Arsenale della S. Inquisizione," that "*esame rigoroso*"[2] was exactly equivalent to "torture," and that this passage of the sentence was absolutely decisive of the whole question. Wohlwill shows, by a complete scrutiny of the "Sacro Arsenale," that a "rigorous" examination in most cases meant one conducted under torture, but that this expression sometimes denoted a less severe procedure. It appears that where the course of the preliminary investigation led the judges to suspect that the accused had not stated the entire truth, three distinct and increasingly intense trials of fortitude and endurance were prescribed for successive adoption. First the prisoner was brought into the ordinary hall of audience and told briefly and sternly that unless he could make up his mind to confess the truth, recourse would be had to the torture. If this produced no result, he was next carried into the torture-chamber, where the use of the various instruments was explained to him, or he was even seized by the attendants, stripped of his clothes, and bound upon the rack, so that nothing remained but to set its machinery in action. In this situation he was again invited to save himself by confession. If he still remained firm, the infliction of the torture at once ensued. The two preliminary appeals to terror were described as the "verbal scaring" (*territio verbalis*), and the "real scaring" (*territio realis*), while the words "rigorous examination" were reserved, strictly speaking, for the final scene of actual agony. It is clear however, from passages of the "Sacro Arsenale," that in certain cases confessions elicited by the second method of proceeding were described as made under the rigorous examination, though this laxity of expression is explicitly stated not to extend to the first. The text of the sentence against Galileo therefore implies, at the least, that he was carried into the torture-chamber and submitted to some form of the *territio realis*.

The same authoritative document informs us what was the general character of his replies under this ordeal. He answered "in a catholic manner," *i.e.*, denied that he held the reputedly heretical doctrines attributed to him. While stating this fact the Court were careful to insert a saving clause that the answers so given were not to prejudice other points admitted by or proved against the accused. The significance of this clause, which preceding writers appear to have passed unnoticed, is, according to Wohlwill, as follows:—So great was the regard professed by the Inquisition for assertions steadfastly adhered to under the torture, that in regard to whatever formed the actual subject-matter of a rigorous examination, the answers of the accused, if he thus stood by them, had to be

[1] "Giudicassimo esser necessario venir contro di te al rigoroso esame."

[2] Wohlwill has shown that Italian, and not, as has hitherto been assumed, Latin, was the language in which the sentence was promulgated.

accepted as true. It was therefore the interest of the Court carefully to define the limits within which it proposed to allow the accused this chance of escape. The saving clause under consideration was devised for this very purpose, so as to prevent answers made during the rigorous examination from possessing the power of voiding articles of charge or admission not explicitly included in the questions of the interrogating official. Its actual application was, of course, made at the opening of the rigorous examination as a preliminary to the torture, and the fact of the *caveat* being formally recited in the subsequent sentence is held by Wohlwill to confirm his view that Galileo was submitted at least to a *territio realis* in the torture-chamber.

After this examination of the evidence supplied by the sentence, our author next shows, in opposition to a considerable body of influential opinion, that there was nothing in the circumstances of Galileo's case to negative antecedently the application of torture, and no ascertained subsequent fact inconsistent with its having been inflicted. The absence of any reference to it in his few remaining letters of later date than the trial is completely accounted for by the oath of absolute silence imposed upon all who appeared before the tribunal of the Inquisition. The fact that Galileo was released from the custody of the Court three days after his final examination, and ten days later was able to take active exercise, shows only that severe torture was not inflicted, but by no means excludes the milder form (*leggiera tortura*), to which the Inquisitional manuals distinctly refer. The advanced age of the prisoner, who was at this time seventy, does, it is true, afford a certain degree of presumption in this direction, inasmuch as Inquisitional authorities usually incline to stop at the *territio realis* in the case of aged persons; they give, however, the alternative of applying "a kind of torture suitable to old people," so that this indication is, after all, far from conclusive.

This clearing of the ground is followed by a detailed investigation of the minutes of the trial contained in the Vatican record, so far as they bear on the question at issue. It thence appears that on June 16, 1633, Pope Urban VIII. ordered the prisoner to be interrogated as to his object in publishing his dialogues on the Ptolemaic and Copernican systems, threatened with the torture, and, if this failed to elicit a confession, condemned to abjuration and imprisonment during the pleasure of the Congregation. On June 21 this examination accordingly took place. Galileo was asked whether he held, or had held, that the earth was in motion and the sun at rest. He denied having done so since the decree of the Index on March 5, 1616, and though pressed by his interrogator with the contrary indications afforded by the dialogues themselves and repeatedly urged to tell the truth freely, clung to the denial. On being told that if he persisted further recourse would be had to the torture, he simply reiterated his former statement with this addition: "I am here in your hands, deal with me as you please." At this point the report abruptly terminates with a few words stating that nothing further could be done, followed by the signature of Galileo in attestation of his own deposition. Wohlwill points out that the threat of torture here recorded as delivered in the ordinary hall of audience cannot possibly count as a rigorous examination, since, according to the fixed language of the Inquisition, the latter proceeding did not begin until the officials and the accused had taken up their positions in the torture-chamber. There is therefore a direct contradiction between the sentence, which affirms that a rigorous examination was held, and the official minutes, which relate nothing capable of answering to that designation. It is the deliberately expressed opinion of the German investigator that this contradiction points to a fraudulent tampering with the trial-record, perpetrated at a time when it had become advisable, in the interest of the Roman hierarchy, to obliterate, as far as possible, the traces of a mode of treatment adopted towards the great Italian astronomer which, if once allowed to become notorious, would raise a cry of indignation throughout Europe. In support of this view its author has arrayed a very strong body of evidence, many particulars of which are of singular cogency. It is indeed in this latter portion of his work, where he examines the general claims of the Vatican manuscript to be considered a complete authentic and unaltered record of Galileo's trial, that Wohlwill does the most meritorious service. An attempt to determine to what precise stage of barbarity the Inquisition advanced in its dealings with its illustrious prisoner is after all a matter of secondary interest. On the other hand an energetic effort to ascertain how far the only official account we possess of perhaps the greatest event in the whole history of science is genuine and trustworthy, must be admitted to be an undertaking of signal importance. Enough, and far more than enough, has been achieved in this direction in the present work to excite the gravest suspicions and fully to justify the warning which at its close Wohlwill addresses to the Roman authorities, that in the present condition of affairs only two courses remain open to them; either to appear as accomplices in atrocious frauds, or to bring the whole truth to the light of day Nothing less than a thorough examination of all the remaining original records by competent and trustworthy palæographers can possibly settle the issues now definitely raised.

SEDLEY TAYLOR

The current number (January 16) of the *Rivista Europea*, which reached me after I had completed the above notice, brings a review of Wohlwill's work by Dr. Scartazzini, containing original matter due to his own independent research. The Italian critic has made strenuous use of the latest, and incomparably best, edition of the Vatican manuscript, that by Herr v. Gebler, and arrived at conclusions in regard to the falsification of its text considerably more sweeping than those based by Wohlwill on the less complete information accessible prior to the appearance of v. Gebler's edition. As far as the two writers cover the same ground they essentially agree in their verdict; the difference between them merely being that the Italian theory is more extensive than its German predecessor. It is gratifying to me to find the eminent position among historical critics to which the depth, clearness, and high originality of Wohlwill's writings on this subject in my judgment entitle him, claimed for him with equal confidence by Scartazzini. I regret that the exceedingly technical nature of the new arguments now advanced makes it impossible to give any idea of them here. They aim at pointing out the exact

nature of the excisions, transpositions, and other devices by which the Roman forger set to work to eliminate from the manuscript all trace of Galileo's having been, as Scartazzini stoutly maintains that he was, submitted to the actual torture. S. T.

THE AGRICULTURAL SOCIETY

The Journal of the Royal Agricultural Society of England. Part II., 1877.

THE current number of the Royal Agricultural Society's *Journal* is chiefly occupied with reports of the agricultural exhibitions held during the present summer at Liverpool and at Hamburg, and with reports on farms in Lancashire, Cheshire, and North Wales, which obtained the Society's prizes for good management at the Liverpool meeting. Another report deals with prize farms in Ireland in connection with the competition for small farms instituted by Earl Spencer. Besides these we have two lengthy papers on the American export meat trade, by Prof. Sheldon, of Cirencester, and by Prof. Alvord, of Easthampton, Massachusetts; three papers on village clubs, by Sir E. C. Kerrison, and Mr. Lawes; a paper on the impurities of clover seed, by Mr. Carruthers; and a short report of some investigations on foot-and-mouth disease, conducted at the Brown Institution.

The international exhibition at Hamburg was one of considerable importance: it was devoted exclusively to dairy husbandry. Lying, as Hamburg does, in the immediate neighbourhood of the great dairy countries of Northern Europe, an excellent opportunity was afforded of noting the advance made in dairy work during the last few years. The great improvement which has signalised this period is undoubtedly the use of ice in cream-setting. This invention dates from 1864, and is the work of J. G. Swartz, a Swedish farmer. In the ordinary method of cream-setting the milk is placed in very shallow pans, and stands for thirty-six hours or more while the cream is rising. The milk during this time usually turns sour, and the cream becomes contaminated with free fatty acids, with partially decomposed albuminous bodies, and with other products injurious to the flavour or keeping qualities of the butter. In Swartz's plan the milk, as soon as it reaches the dairy, is placed in deep metal pails, standing in a vessel full of ice. Not only does the low temperature reduce the process of change to a minimum, but, quite unexpectedly, it also greatly facilitates the rising of the cream; so that in pails having sixteen inches' depth of milk the cream is nearly all obtained in twelve hours. The butter churned from this sweet cream is not only very pure in flavour, but has remarkable keeping qualities. This plan, which is rapidly spreading in the north of Europe, and in the United States, is at present scarcely known in England. One obstacle to the general use of the method is undoubtedly the difficulty of procuring a sufficient supply of ice in such a climate as ours. This difficulty has been greatly diminished by the investigations of Prof. Fjord, of Copenhagen. He has shown that snow, if collected after thawing has begun, may be easily trodden into as small a compass as ice, and may be used with equal economy. The collection of snow is also far less laborious than the carting of ice, as the snow may be gathered in the immediate neighbourhood of the homestead. Let us hope that English dairy farmers will not be slow to adopt the scientific methods of their continental brethren.

Statistics regarding the meat-producing capabilities of the United States and Canada are fully given by Profs. Sheldon and Alvord. The number of cattle in the United States is at present about 28,000,000, or three times as many as those in Great Britain and Ireland. The proportion of cattle to population is, in the United States and Canada, about 67 : 100; while in the British Isles the proportion is about 29 : 100. The total area of the farms in the United States is about 8½ times that of the farmed land in the British Isles, while vast tracts of country yet remain to be cultivated. In 1875 the number of acres under Indian corn in the United States all but equalled the whole number of acres under cultivation in our own country.

With such enormous capabilities of production, the only condition wanting for a large export trade is a cheap and efficient means of transit. That such a mode of transit has now been established is proved by the quantities of meat already exported to England. We received in 1876, from New York and Philadelphia, 19,838,895 lbs. of fresh beef; and the trade has so rapidly extended, that in the first four months of 1877 the imports exceeded the whole import of the preceding year, and amounted to 22,812,128 lbs.

The means adopted to preserve so perishable an article as fresh meat during the long journey from America to England is artificial cold. The cattle are slaughtered at the port of embarkation. At the establishment in New York an ox is killed, and the skin and offal removed in the space of three minutes. The carcase is then cooled to 40° F. in a room through which a constant current of cold air is maintained from an ice chamber. After forty-eight hours the carcase is cut up, and placed in the refrigerators of the steamer, and thus conveyed to England. During the voyage a temperature of 37°—40° is maintained, a stream of dry cold air being circulated through the meat-chamber.

The source of cold has hitherto been ice, but a new cooling agent of great power and adaptability promises soon to supersede the use of ice. The invention is due to Messrs. Giffard and Berger, of Paris. In their process air is condensed by a steam-engine, the heat evolved on condensation being removed by a stream of cold water. The cool condensed air is then conveyed to the chamber which is to be refrigerated, on entering which it is allowed to expand again to atmospheric pressure. The cold thus produced is intense. The ease with which the cooling power can be conveyed to distant places, and the fact that ventilation, as well as cold, is accomplished, will probably procure numerous applications for this valuable invention.

For the extension and success of the American meat trade we now only require to erect suitable refrigerating stores, and to provide refrigerating railway-cars, for the safe conveyance and preservation of the carcase after it has reached our shores.

We have no space to refer in detail to the remaining articles. Those who feel an interest in the improvement of the agricultural labourer will find much suggestive matter in the papers on village clubs, while the kindred

subject of the improvement of peasant farmers is ably discussed in Prof. Baldwin's report on the Irish prize farms. R. W.

OUR BOOK SHELF

Oregon: its Resources, Climate, People, and Productions. By H. N. Moseley, F.R.S. (London: Stanford, 1878.)

THIS little manual is the result of a visit paid in July and August last by Mr. Moseley to Oregon. Mr. Moseley gives not only the results of his own observations, but has taken the trouble to consult carefully and give the gist of official publications on the state, the result being a thoroughly satisfactory, full, and trustworthy account of the present condition of Oregon. Mr. Moseley has done a public service in undertaking this task, and we recommend his book to all who contemplate emigrating. It will answer nearly every question an intending emigrant is likely to ask, and gives, moreover, very definite advice as to the kind of people for which the state at present is suited. The book contains an excellent map of the state.

A Handbook of Common Salt. By J. J. L. Ratton, M.D., M.C. Madras College. (Madras: Higginbotham and Co., 1877.)

THIS work is not to be judged as a scientific treatise, but as a practical guide to the manufacture of common salt from sea-water. The author has fulfilled the purpose which he set before himself in compiling the book. Starting with a brief historical introduction, he proceeds to lay before the reader a concise statement of the principal chemical and physical qualities of salt. The occurrence of salt as a mineral is then shortly discussed; the analysis of natural salt occupies a small chapter, which is succeeded by others upon the hygienic value of salt, and upon the agricultural uses of the same substance. The principal rock-salt deposits are described, and the mining operations sketched.

After these chapters, which must be considered as introductory, the composition of sea-water is discussed; the leading facts concerning evaporation of solutions of mixed salts, and fractional precipitation of the saline substances, are clearly laid down, and upon these the theory of salt manufacture is shown to be based.

Details of the salt manufacture are then given, followed by descriptions of the growth of "spontaneous salt," of the manufacture of salt from brine springs, of "earth salt," and lastly, of salt lakes. The final chapter is devoted to a discussion of the bearings of taxation upon the salt trade.

The book is written from the Indian view-point, and is rich in local illustrations of the manufacture; but the author has endeavoured to make, and we think has succeeded in making, the work a really good manual of general applicability.

The author is to be praised for the carefulness with which he has gathered together and arranged a large mass of facts; the result is a most useful and convenient little book of reference. M. M. P. M.

LETTERS TO THE EDITOR

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[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The "Phantom" Force

THE famous principles of conservation and dissipation of energy, which have done so much to promote the progress of physical science in recent years, were undoubtedly first inferred and generalised from certain similar laws in the theory of forces which, as we find noticed by Prof. Tait in NATURE (vol. xiv. p. 462), were first propounded by Newton.[1] If in any mechanical system, Newton observes, urged by any forces, to which we must add those which arise from friction, the action of a force reckoned *as a gain* in the system is measured by the product of its impulse and the space through which it is pushed back, or as a loss in the system when the product relates to a space through which the force *is allowed to act*, and if as action of the same kind in the system we also count its gains and losses of actual energy of motion, the whole amount of action in the system remains unchanged during the motion. Viewed from the standpoint of the laws of motion, force, and matter, which Newton starts with in the "Principia," and keeping in mind the special definition here given (coinciding with the modern term "potential increase") of the "action" of a force, obviously the reverse of what would vulgarly be called the action of a force *in increasing* a body's energy of motion, this proposition at first looks like a truism; but the idea of potential energy here coined by Newton[2] is really an essential one; and it besides allows the mode of action of some forces of very common occurrence in nature to be described more simply than they could be without it. The force of gravitation, of attraction and repulsion between two bodies permanently electrified or magnetised, and all dual forces or actions and reactions directed along, and depending only on the distance between two bodies, and not at all upon the time, are of this kind. The force can be completely described in these cases (and it may be looked upon in the first instance as only a measure of convenience) by the permanent gradient of energy-variation everywhere; and hence also by the permanent change of energy from one distance to another, when, as is supposed in this example, the dual force pair acts along the line of centres; since then the changes of actual energy which it produces (acting alone upon the bodies) are independent of the rotation of this line, and may be regarded either as produced with the natural motion of this line's rotation or by the same forces acting along a fixed line of centres. When two such bodies approach, or recede from each other, whatever time elapses or whatever course they may pursue about their centre of mass, not only are the momentary transfers between actual and potential energy equal in energy value at every moment of the motion (for this is *general*, and by this condition *only* the bodies returning twice to the same distance from each other might have very different energies of motion at the two returns); but the whole energy of motion which can be gained between two distances is a definite one, and as this would not be so if the bodies returned twice to the same distance with different actual energies, nor if they returned twice to the same distance with different potential energies, it follows at once that not only is the sum of the actual and potential energies at any one distance invariable with the lapse of time and with any intervening motions of the bodies, but since the gain of actual energy from this distance to any other *is the loss* of potential energy, the sum of these two energies is also the same at one distance as it is at another, and it therefore varies neither with the time nor with the distance of the bodies from each other.

In this illustrative example, of two bodies (otherwise unimpelled) exerting upon each other a permanent action and reaction, several points connected with the use of the term "potential energy," as just described, require attention. In the first place, whatever the real forces are (acting in "absolute space"[3]) upon the two bodies, the Newtonian laws of motion

[1] On reading the passage again (which I here described from memory) I find that its statement is verbally but not substantially different from what I wrote above, and that in Newton's statement the signs are merely taken oppositely. Newton thus describes an "acceleration" (a gain of actual energy) as a "resistance" (*i.e.*, a force) overcome, with a corresponding loss of action in the system. This is the modern view of equivalence between potential and actual "action" or energy, but *with the signs of* these actions changed.

[2] Newton, in fact, anticipated D'Alembert's principle; and if we apply D'Alembert's principle to the motion of a single particle, the way in which it likewise coincides with the modern definition or recognition of potential energy will presently be understood, although it also reverses the signs of both of the energies concerned.

[3] The term "absolute space," or the simpler word "space," used in Newton's enunciations of the laws of motion as the field of action of "force" is nothing more than a space whose origin is either the centre of mass of all the bodies under actual observation, or any space in which that centre is moving uniformly in a straight line. If we extend our observation to new bodies found not to be moving uniformly in the original space, the old space must be given up, and a new one must be adopted (recognising the new masses), to enable us to state all the forces and to describe the motions completely, of all the bodies under observation (which is the sole problem and

establish that their whole effect in altering the energy of motion of the two bodies at any instant is divisible into two parts, that which the forces, removed to the centre of mass of the pair, and acting there on their joint mass, will have on the joint mass in absolute space, and that which is represented by the sum of the bodies' changes of actual energy reckoned in a space which has this centre of the masses for its origin. If we call the latter changes their local changes of energy, and professing ourselves entirely ignorant of motion and position in absolute space, confine our attention to describing the motions of the bodies in the specified or local space, the abstract laws of dynamics again tell us that in this local space the motion of the bodies is what arises from an equal and opposite action and reaction exerted mutually between them. Suppose this to be of the permanent kind above described (which occurs frequently in natural actions, as already mentioned), then as regards the local motion and its forces (now equal and opposite, and quite distinct from what they were abstractly), the above proposition may be predicated of them which asserts that the local energy of motion and local potential energy together have a constant sum. In our circumscribed sphere of observation the energy of motion is entirely known, or in other words, if we follow the bodies along any course from one point to another, not only all the changes and the sum of the changes of their actual energies, but also their energies at first, and therefore their energies at last, are known by a successive process of integration. We know from the permanency of the energy-gradients along the line of centres that the sum of the energy changes between the two given points is independent of the course or lapse of time in which the final point is reached. Instead, therefore, of making a new successive integration for every course, one such integration for all expresses the total change of energy between the points, and as this is possible for all points or configurations which the bodies can reach from their first configuration, if a scale of such energy changes reckoned from some starting one is made out for all the different distances from each other at which the bodies can be, the scale value will be nothing at the starting distance, and will have determined values at all other distances. We would use the scale by saying that the actual energy at any distance only differs from the scale value by the starting-energy to be super-added; or the excess of the actual energy above the scale value is everywhere constant, and everywhere equal to the actual energy at the initial point. This concise description of the motion, as far as the actual energy at any moment is concerned, accords with the mathematical usage of collecting variable quantities thus simply related to each other and to constant quantities on one side, and constant quantities on the other side of an equality; but a further simplification of its expression is effected if those scale values which mean increase of energy from the starting-point are called "negative," and those denoting loss or decrease of actual energy are called "positive"; for having constructed a new scale on this convention (which we may call the negative scale), to use it we must first change the sign of any value in it before applying the last proposition. As that expression tells us that the remainder, on subtracting the former scale value from the actual energy at any point, is constant, this operation of subtraction, after altering the sign of the new scale value, is simply equivalent to adding the new scale value without altering its sign. With this convention, therefore, that an increase of actual energy is a negative increase, or, in other words, a decrease of the negative scale value, we may put the sentence describing the actual energy in every part of the motion in these much simpler words. The sum of the actual energy and of the negative scale value is everywhere constant and equal to the actual energy at the starting-point of the scale, which we may call the initial actual energy. When increase of actual energy coincides with decrease of "negative scale value" (as we have just seen), and also as it is usual to express it with "work done by a force," increase of negative scale value represents work done against a force as it is expressed in the new phraseology of the science of energy, or with "potential work." The actual energy of the material couplet is everywhere fixed and determinate (when it is once started), but if we speak of the negative scale value as "potential energy" the amount of this at various distances depends upon the distance chosen as the initial one, when it is zero. Thus if we reckon the potential energy of a swinging pendulum, drawn by gravitation towards the centre of the earth (whose motions of rotation and of oscillation relatively to the common centre of the globe and of the pendulum-bob may be disregarded, so that, with the exception of gravity, only a force perpendicular to its motion guides the bob in a space, referred to the common centre as origin, which we may identify with the place of the experiment) from the top of the arc, where the actual energy of the bob is zero, this must be the sum of the values of the actual and potential energies throughout the motion, and consequently at the highest point the potential energy is zero, and everywhere else it is negative, while at the lowest point of the arc, where the actual energy is a maximum, the potential energy reaches its greatest negative value. If, on the contrary, we select the lowest point of the arc as the starting-point, and call the potential energy at this point zero, making the sum of the two in all parts of the motion thereby equal to the greatest value which the actual energy can have, the potential energy must elsewhere supply the deficiency as the actual energy abates, or have positive value in all other positions of the bob, and at the highest points of its swing, when the actual energy entirely disappears, it will reach its greatest positive value, equal to the greatest value of the actual energy at its lowest point. By one such system, therefore, the motion is as perfectly described as by the other, and by a different choice of zero-points the individual amount of the potential energy is thus evidently disposable at pleasure, while its difference between two points yet always remains the same. But by taking the zero point where the actual energy has its greatest value, the advantage is obtained, as in the last arrangement for a pendulum, that the potential, like its partner, actual energy, will never be less than nothing, and its values will always be positive. With its zero point so taken, and with a special choice of mass in the moving body attracted or repelled, whose course is followed, the series of negative scale values or of potential energies just described is termed "the potential" or the "potential function" of the force upon it; but its definition for any permanent force-pair supposes the total absence of all such constraining forces as these of the pendulum string, and the bodies must be left perfectly free to approach or recede from each other to the centre, or to the furthest imaginable distance unimpeded by any forces foreign to the pair. In such material couplets it is also sometimes customary to reckon their combined energies actual and potential in a space having for its origin one of the bodies themselves instead of the centre of their mass. The motion of the standard body then disappears, and that of the other body becomes the relative motion of the two, while at the same time a certain mean mass must be supposed centred in the moving body, so that when the product of this, multiplied by its new acceleration, is taken, its impulse relatively to the stationary body (which is now the rate of change of energy of the pair with the distance between them) may not undergo any alteration by the change of origin. Reckoned in this way, either of the bodies may be said to have energies of motion and configuration in the space relative to the other body, whose sum is constant.

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(*To be continued.*)

purpose of mechanics). If we continue this process until all the bodies of the material universe are brought, with a knowledge of their masses, under our observation, we reach that abstract field of force, or force-space, which is contemplated in Newton's enunciations. This space may be identified with absolute space, because the centre of mass of the universe by which it is defined is as perfectly abstract and metaphysical an idea as any that we can form of absolute space, on the simple ground that we have no reason to attribute to matter a less boundless and limitless extent in the universe than we ascribe to space itself. To define one metaphysical idea by another is not unscientific, nor is the description of force which Newton gives more repugnant to the eyes of common sense than the ideas which we form, though quite indefinite, of the extent of the material universe, and of the boundless realms of space. A special office, it may also be suggested as very probable, may be assigned to force, to avoid the occurrence of superposition and mingling of matter in the same points of space, or to give matter impenetrability.

Aid of the Sun in Relation to Evolution

IT is not often that it will fall to the lot of the physicist to harmonise such important theories as those of evolution and the nebular hypothesis, and much credit is due to the boldness and the originality of Dr. Croll's attempt to do this. At the present time the great majority of scientific men hold the truth of both of these hypotheses in spite of the fact that serious difficulties exist in them which admit of only doubtful explanation, so that it is certain they would be considerably strengthened if it were found possible to dovetail them one to the other without unduly straining the conditions of either. That Dr. Croll has effected this important service is, I think, very questionable, although I fully believe it is attainable.

In advocating his own views in NATURE (vol. xvii. pp. 206, *et seq.*), and in his other publications Dr. Croll has anticipated

two formidable objections which he foresaw would be brought against them, namely, the improbability of two bodies endowed with enormous energy in the form of rapid motion coming into actual collision with one another, and secondly, the want of experience of like movements in the universe. It is but seldom that a theory, however ingenious, can be upheld against *two* antecedent improbabilities, but granting Dr. Croll all he asks, even to the existence of non-luminous bodies moving through space with a velocity of 1,700 miles per second, there may still be brought more serious objections than either of the above. Our knowledge of the actual motions of the stars in space has recently been greatly extended, and it is now well known that proper motions exceeding thirty miles per second are very rare, and that probably there is no well-authenticated case of a velocity greater than forty miles per second. It has long since been ascertained also that the proper motion of our own sun in space is at the rate of four miles per second only. It is, of course, possible or fortunate that the two bodies from whose collision the solar nebula originally derived its vast stores of heat might be of such equal masses and velocities that the motion of translation should be so nearly destroyed, and the whole converted into heat, but it is inconceivable that amid all the diversity of dimensions of the heavenly bodies it should invariably happen that the resultant movement of the combined masses should be reduced to such insignificant figures as the above.

It is strange that it should not have occurred to Dr. Croll that the heat generated by the impact of two bodies in such rapid motion cannot be considered as remaining constant for nearly the length of time he computes, because the rate of radiation from so intensely heated a sun will be enormously greater than it is now. Indeed the origin of the solar heat does not materially affect the question at issue, which is rather of the means of continuous and equable supply than of the primary source. The contraction theory of Helmholtz addresses itself to meet this difficulty, but alone it is probably insufficient. In the *Popular Science Review* of January, 1875, I have directed attention to other possible and supplementary means of heat supply, which, being continuous, will tend to prolong the period during which the radiation of heat from the sun shall be nearly constant, and hence favourable to the development of organic life. Without advocating any peculiar views of my own which recent discoveries have necessarily somewhat modified, I content myself with pointing out what appear to me to be grave difficulties in the way of accepting the theories and explanations of Dr. Croll.

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Faraday's "Experimental Researches"

DOUBTLESS many of your readers will have observed an advertisement of a well-known antiquarian bookseller professing to be able to supply "a perfect copy" of Faraday's "Experimental Researches" at a price not too exorbitant for a complete original copy of that priceless work.

Any who may have applied for the work will, perhaps, share with me the indignation with which they discover that the so-called *perfect copy* is only such in virtue of being a "facsimile reprint" (*sic*) not twelve months old, though dated on the title-page 1839. But perhaps scientific men are too innocent of the ways of antiquarian caterers to receive with calm contentment the assurance that they have not been deceived.

SILVANUS P. THOMPSON

University College, Bristol, February 5

CLAUDE BERNARD

IN rapid succession we are compelled to chronicle the recent serious losses by death to French science. To the names of Leverrier, Becquerel, and Regnault, we regret to add that of the equally famous physiologist, Prof. Claude Bernard, who died in Paris on the evening of February 11. He was born at St. Julien, near Villefranche, in the Rhône department, July 12, 1813. After completing a course of study in the Paris faculty of medicine he was appointed hospital-surgeon in 1839. Two years later he became assistant to the well-known physiologist, Prof. Magendie, in the Collége de France, and continued in close connection with him for thirteen years, during the last half of this time lecturing himself as *privat-docent*. A series of notable discoveries made during this period caused his election, in 1854, to the Academy of Sciences, and his appointment to the newly-founded professorship of general physiology in the Collége de France. This he exchanged in the following year for the chair of experimental physiology, a position which he occupied up to the time of his death.

As an original investigator, Bernard stands among the foremost of the century. He entered upon his career at the epoch when Magendie, the chief founder of the modern French school of physiology, had completely altered the character of this study by the introduction of a variety of experiments on living animals, such as the action of the alkaloids, &c. Bernard entered with enthusiasm on the new field of experimental activity opened up by his master, and by a swift succession of remarkable discoveries with regard to the changes taking place in the human organism, guided the young science into a completely new channel. Of these the most important were connected with the phenomena of digestion, and especially the relation of the nerves to these processes. Perhaps the most valuable was the exhaustive investigation into the functions of the pancreatic juice (in 1850), in which he showed that this fluid was the only one in the digestive apparatus capable of so modifying fatty matter that it can be absorbed by the chyle ducts, and that the digestion of this portion of the nourishment introduced into the system was its sole purpose in the animal economy. Another discovery at this period, which attracted universal attention, was that of the saccharine formation in the liver. Bernard found that not only was sugar a normal constituent of the liver, but that while the blood, on entering into this organ, was completely free from saccharine matter, large amounts of the latter could be detected after it left the liver to pursue its way to the heart. Interesting as this fact was, it was eclipsed by the discovery of the two remarkable connections between this function of the liver and the nervous system.

It was ascertained, first that this normal formation of sugar in the liver could be totally interrupted by severing the pneumo-gastric nerve in the neighbourhood of the heart; and secondly, that by wounding a certain place on the fourth ventricle of the brain, near the origin of the eighth pair of nerves, it was possible to cause such an abnormal formation of sugar that an animal within two hours after such an operation showed all the symptoms of diabetes. In recognition of these brilliant experiments the physiological prizes of the French Academy were bestowed upon Bernard in 1851 and 1853. In a continuation of this line of research in 1859 he made the important discovery that the sugar for the embryo is prepared in the placenta, and not in the liver. Shortly previous to this time he published the results of extensive observations on the temperature of the blood, in which he showed that remarkable alterations in the degree of warmth take place on the passage of the blood from one organ to another, especially in the different parts of the digestive and respiratory systems. The absorption of oxygen by the blood formed the subject of a memoir in 1858, from which it appears that the coefficient of absorption diminishes gradually with an increase of temperature, and becomes zero at 38°—40° C. in the case of mammals, and 40°—44° C. in the case of birds, viz., at the temperatures at which death sets in. The respective amounts of oxygen in the arterial blood, and red and black venous blood were likewise carefully estimated, and the chemical causes for the differences in colour revealed. Among the other leading researches of Bernard must be mentioned those on the comparative properties of the opium alkaloids; on the poisonous properties of curarine; on the sympathetic nerves in general; as well as numerous investigations on the individual processes in the act of digestion. Many of these discoveries, as well as the results deduced from them, have formed subjects for long-continued controversies. With rare exceptions, however, not only

Bernard's experimental correctness, but the soundness of his theoretical deductions, have been universally recognised by leading physiologists.

As an author Bernard was not so fertile as most of the scientists of the present day in France. The few works emanating from his pen are regarded as standard even outside the limits of his own country. This is especially true of his "Leçons de Physiologie Expérimentale Appliquée à la Médecine" (1865), a work valuable not only for the exceedingly thorough, systematic, scientific treatment of the subject, but also on account of the numerous indications for the application in medicine and surgery of the results gained by physiological research. His other works are "Leçons sur les Éffets des Substances Toxiques et Médicamenteuses," 1857, "Introduction à l'Étude de la Médecine Expérimentale," 1865, and "Leçons de Pathologie Expérimentale," 1874.

As a lecturer Prof. Bernard was not only peculiarly successful in the professor's chair, but was also distinguished among the *savans* of Paris for his able and lucid presentation of scientific facts to general audiences. He was busily engaged in the fulfilment of his professorial duties when the short sudden disease preceding his death interrupted the courses of lectures, and put an end to a life of rich and varied scientific activity.

As a mark of the universal respect and honour in which he was held, the authorities of the French Republic have decided that his funeral shall be at the expense of the nation.

T. H. N.

A PHYSICIAN'S EXPERIMENT

AT a public lecture at Salisbury Hall, Oxford Street, recently, Dr. T. L. Nichols, of Malvern, related particulars of a "Dietetic Experiment" upon himself, which he had made with a view to solving a difficulty as to the quantity of food per diem which would best sustain health. He had always been temperate, his only excess being to be overworked. He rose between five and six, and worked well through the day, but avoided night-work. He seldom knew pain, never took medicine, and had excellent health. He usually ate twice in the twenty-four hours, at nine and five, because, for him, long rest for the stomach was better than shorter intervals. He appeared to sleep better for not eating after four o'clock. Every one should sleep upon, at least a quiet stomach. He had carefully noted the "dry weight" of the food he had taken, oatmeal, &c., he counted as dry weight. The weight of water forming a large portion of all food had not been reckoned, because it did not supply nutrition. Eggs and milk were perfect foods, but were largely composed of water. Milk was the most perfect food, though not the best for adults. He began on November 5, his food being chiefly bread, fruit, milk, and vegetables. During the experiment he had taken no flesh meat, wine, beer, spirits, tea, coffee, or tobacco. With regard to smoking, if it were the good thing people said it was, why not encourage their wives and daughters to smoke? Medical authorities differed as to the quantity of food that should be eaten, and it was a common belief that the more food we ate the greater would be our strength.

The first week, the lecturer stated, he lived on bread, milk, fruit, and vegetables, the total weight being 3lb. $9\frac{1}{2}$oz, costing 3*s.* 1*d.*, *i.e.*, a daily average of $8\frac{3}{14}$oz., costing $5\frac{2}{7}$*d.*; this was slightly below his standard of 6*d.* a day. He felt better, and clearer, and brighter than usual. The second week he studied quality rather than cheapness, his food being Food of Health, milk and fruit. Total weight 4lb. $4\frac{1}{2}$oz., cost 3*s.* 8*d.*, average per diem $9\frac{5}{7}$oz., costing $6\frac{2}{7}$*d.*, and nothing could have been better, physiologically, than the effect of that food upon him. His digestion was simply perfect, and the action of the whole system as good as it could be. He then discontinued milk as unnecessary. For the third week the total amounted to 3 lbs. 2 oz. = 1*s.* 9*d.*, giving an average of $7\frac{1}{7}$ oz. of food costing only 3*d.* per day. Milk was not so cheap for food as Gloster, Dutch, and American cheese; because they had to pay for the water it contained. Doctors recommended 2 or 3 lbs. of food daily to repair the waste of the system; but he asserted that the waste of brain atoms and nerve force could not be measured. The food eaten had to be disposed of at great cost of life and strength, and he believed the wisest plan was to eat the smallest quantity that would properly support the body. The fourth week, his food being similar, weighed 3 lbs. 6 oz., costing 1*s.* $2\frac{1}{2}$*d.*, giving an average of 8 oz. = 2*d.* per day. He considered *8* oz. the ***minimum*** and *12* oz. the ***maximum*** quantity of food that should be taken per day. The total weight of his food during the four weeks was 14 lbs. 6 oz., costing 9*s.* $8\frac{1}{2}$*d.*, average per week 3 lbs. $9\frac{1}{2}$ oz.; per day $8\frac{1}{2}$ oz., costing per week 2*s.* 5*d.*, and per day $4\frac{1}{7}$*d.* He then added soups, puddings, eggs, &c., and the fifth week his food weighed 3 lbs. $12\frac{1}{2}$ oz., costing 3*s.* 4*d.*, being at the rate of $8\frac{4}{7}$ oz., a $5\frac{5}{7}$*d.* per day. For the sixth week the figures were 63 oz., at 2*s.* 1*d.*, or 9 oz. at $3\frac{4}{7}$*d.* per day. He had taken the diet without stimulants and had experienced a constant increase of health and strength and power to work, and his weight had remained at about 12 st. 2 lbs., except that at the end of the fourth week there had been a slight decrease which had since been recovered. The experiment had been fairly made upon an average subject and the results were satisfactory. He was convinced that they ought to give rest to the stomach, and that this would cure all cases of dyspepsia. The diet question was at the root of all diseases. Pure blood could only be made from pure food. Proper attention to diet would reduce the rate of infant mortality and remove many diseases. If the drink of a nation were pure and free from stimulating qualities and the food was also pure the result would be pure health.

SOCIAL ELECTRICAL NERVES

OUR modern Mercury since the year 1846, when the first system of electrical highways was laid down from the metropolis to Norwich, Southampton, Crewe, and Exeter, has not been idle. The wonderful development of the laws enunciated by Wheatstone which regulate the transmission of electric currents through solid conductors has resulted in some very remarkable inventions. At the date at which we write, from a crude beginning when with difficulty electric speech could be conveyed to such limited distances as Manchester and Norwich, we are now able to record the transmission of the Queen's speech to the confines of the empire in a few minutes.

Since the first introduction of private and social telegraphy in 1861, when Reuter first proposed to connect the Reporting Gallery of the House of Commons with the editor's room of each of the leading metropolitan newspapers, the electrical wire has become the means of reducing the cost of newspapers and of sending the news almost simultaneously over the country. Before that time the press paid large sums for "special correspondents," and papers were exceedingly jealous of each other's privileges.

Year by year the public have reaped additional advantages. Submarine telegraphy now includes within its grasp New Zealand, Japan, and the western shores of South America. The private wire system of alphabetical telegraphy between offices and works, carried out over the chief centres of the United Kingdom by Holmes in 1861–5, is in still further process of development. The express speed of the Wheatstone automatic system, duplex and quadruplex telegraphy, and the telephone of Bell, with its delicate electrical sound-wave indications, have all passed into practical existence and become the property of the civilised globe. Still, notwithstanding the advances indicated, much remains to be done.

A recent remarkable advance in the arrangements necessary for utilising the transmitting power of the electric fluid over the metallic nerves of speech we propose to bring briefly under notice.

In every electrical circuit, so far, the limit of usefulness has been restricted to the number of speaking stations or instruments that could effectively be placed in circuit upon the wire, and by the interference and confusion that arises when more than one instrument is used at the same time on such a circuit. To place upon an electrical circuit more than eight or ten instruments has been practically found impossible, the resistance of the instruments themselves being no small element of trouble, while the interference and interruption from multiple speaking has hitherto been found an insuperable difficulty, and one that has greatly tended to clip the wings and usefulness of our modern Mercury. A system that will obviate this trouble and enable any number of instruments to be placed in connection upon the same circuit without the possibility of interference or confusion, opens up a new era in the usefulness of the telegraph as applied to social purposes. It is such a system that will now be described, a system that promises to revolutionise the systems that at present spread over our chief manufacturing cities, and guard the security of property.

A simple illustration will explain the principles of this auto-kinetic system. Let us suppose a tramway to be laid down through the streets and suburbs of any of our large manufacturing centres; the two rails will thread the thoroughfares in every direction, and at each junction, or point of deviation down a bye street or other divergence, a set of points are laid. There is practically no limit to the number of these points that may be placed along the line; they may be one or one thousand. They remain quiescent and of no value as far as the effective running of the car upon the tramway is concerned until the car passes over the special set of points that happen to be required in the transit of the car from its starting-point to its destination. The other nine hundred and ninety-nine sets of points remain ready for use whenever the car has occasion to pass over them, and their presence does not in any way impair the usefulness of the tramway. The one set of points brought into use has been effective in so far that they have enabled the car to reach its destination, and, having been used for a moment, they have again reverted to their original position; while the fact of their being used has in no way affected the utility or efficiency of the remaining points should any be required to pass a car.

Again, suppose two or three cars to be running over various sections of the tramway at the same time, each car could pass over its points on its journey without detriment to the others, although all the cars might be passing points upon the tramway at the same instant of time; the using of these two or three sets of points would not interfere with the remaining 990 odd sets of points which at any moment might also individually be called into requisition. Now the system of electric circuits to be described may be likened to that of the tramway-line, with its accessory junctions and points. A system of two parallel wires is carried through a town. These wires in pairs may be supposed for the purpose of the present explanation to ramify continuously in every direction from a central station up this street and down that, and to embrace within their area the entire commercial and social community. Like the points in the tramway system, so upon the metallic circuit laid down, speaking instruments may be placed at various points and stations along the route, one or 1,000, because in the auto-kinetic system under notice, no instrument is in circuit unless it is, like the points on the tramway-line, being used. A car going over the points makes those points for the time being a portion of the tramway-line. So the circumstance of using the instrument upon the auto-kinetic system makes that instrument for the time being a portion of the electric circuit, and the wires are alone occupied by this transmission.

Should any second or third instrument in other portions of the circuit be brought into requisition at the same interval of time, no interference can take place. As no two cars could run over the same points on the tramway at the same moment, so no two instruments in the system under notice can speak at the same time, but the second or third instrument will automatically succeed the first in the order in which they stand along the line from the central station; just as two or three cars would pass the tram points in the order in which they had been placed upon the line.

The value of this new system of arranging metallic circuits and the instrumental connections, whereby the instrument is only a part of the electrical circuit so long as it is speaking, being thrown off immediately upon the cessation of the speaking current, cannot be estimated or appreciated except by a special reference to its practical development as regards the public and social telegraphy of a large city. This will be fully demonstrated in a subsequent paper by reference to the system of police, fire, and social telegraphs proposed to be shortly carried out for the Corporation of Glasgow, a system at once the most comprehensive and complete that has as yet been devised for affording multiple speaking stations upon the same conducting wires without possibility of interference or confusion.

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

THE STAR LALANDE 19,034.—It is somewhat singular that this star, which was observed by Lalande, on March 21, 1797, and then rated $4\frac{1}{2}$m. should have been so little observed since that year. It is not in Piazzi or Taylor, but it was observed three times by Argelander in the Bonn southern zones, viz., Z. 283, March 6, 1850, when it is called 6m.; in Z. 358, February 16, 1851, where we find it estimated 4m., and again in Z. 400, March 8, 1852, where it is 5m. These circumstances taken together appear to point to considerable variability. The star is in an isolated position on the borders of the constellations Hydra and Antlia. The mean of the Bonn observations gives for its position 1850·0, R.A. 9h. 34m. 26·40s., N.P.D. 112° 54′ 41″·0. Lalande's R.A. is one minute less than Argelander's—yet it looks right in the *Histoire Celeste*. Perhaps one of our meridional observers may find opportunity to revise its position and the star may be further recommended to attention on the score of probable fluctuation of light; though it should be remarked that there are other cases of discordant magnitudes in the Bonn southern zones for stars not yet entered on the list of variables, as in η Canis Majoris for instance, for which in three observations the magnitudes are 5, 3, and 2.

VARIABLE NEBULÆ.—Prof. Winnecke in directing attention to the nebula H. II. 278 as probably affording the first indications of *periodical* variability of a nebula, refers to the one discovered in Taurus on October 11, 1852, by Mr. Hind, as affording the single case where astronomers generally have been agreed as to variation. That nebula was detected on the morning of October 11, in one of the most magnificent skies experienced in the Regent's Park, being caught at once in slow sweeping, with the low power-comet eye-piece of the 7-inch refractor. Towards the end of the year 1876, in a fine sky with the same telescope and eye-piece, not a vestige of it was perceptible, and the same result attended several attempts to discern the nebula in 1874 and 1875. Prof. Winnecke mentions that it is not at present visible in our most powerful telescopes.

MINOR PLANETS.—Observers who are still engaged in the exploration of the region of the ecliptic have given

signs of much activity of late. First we hear of a small planet detected by M. Perrotin at Toulouse, on January 29, position at 10h. in R.A. 8h. 43m. 13s. N.P.D. 71° 41 twelfth magnitude, which appears to have been independently discovered by Herr Palisa at Pola, on February 1: by an observation at Pola, January 27, it seems this object is not to be confounded with *Rhodope*, No. 166, of which a corrected ephemeris is given in the *Circular* of the *Berliner Jahrbuch*, No. 84, but it is there conjectured that it may be *Urda* No. 167, found by Prof. Peters 1876, August 28. Calculating from the elements of *Urda* in *Circular* No. 64, for the time of the Berlin observation of M. Perrotin's planet on February 3, it results that with the correction $\delta M = +5° 24'.9$ the computed and observed longitude will agree, but there is a difference of $-1° 38'$ from the observed latitude which, in the present case, throws doubt upon the presumed identity. Again, on February 2, M. Cottenot, at Marseilles, detected a planet, tenth magnitude, position at 13h. 2m. in R.A., 10h. 2m. 29s. N.P.D., 78° 51′, which was also found by Prof. Peters at Clinton, U.S., on February 4; this object is probably new. Finally, on February 6, Prof. Peters met with another planet, also of the tenth magnitude, in R.A. 10h. 16m. N.P.D. 76° 17′, which he notified to the Paris Observatory through the Smithsonian Institution by cable; it is probable, however, that the presence close to this position of his previously-discovered planet *Antigone*, No. 129, has escaped his attention, and as its brightness would also be about equal to that of stars of the tenth magnitude, it is most likely to be the object observed.

The number of minor planets appears now to have reached 180, and possibly 181.

The Supplement to the *Berliner Jahrbuch*, for 1880, contains ephemerides for the present year, of the small planets to No. 172 inclusive, excepting only *Dike* and *Scylla*, for which the necessary materials are not available. Polyhymnia in opposition on August 30, in 11° S. declination, is distant from the earth 0·88; Atalanta in opposition October 27, declination 37° N., is distant 0·98, and Felicitas in opposition November 11, declination 30° N., is distant 0·92; these are the three cases of nearest approach during the year. Of the minor planets discovered since 1845, Hebe attains the greatest brightness — 7·4 m. in the middle of November, 1878, while in the neighbourhood of ϵ Eridani.

METEOROLOGICAL NOTES

ATMOSPHERIC MOVEMENTS.—A first paper on this subject, by Mr. Ferrel, has been published by the United States Coast Survey Office, in which the inquiry is limited to an investigation into the mechanics and general motions of the atmosphere which are dependent on wide-spread and periodically-recurring disturbances. In consideration of the enormous difficulties in the way of investigating the effects of friction, the author adopts the only course open to him, viz., to introduce unknown functions into the equations representing the resistances from friction in the direction of the co-ordinates, leaving these to be determined approximately from a comparison of the final results deduced from the equations with observation. From a mathematical examination of the question it is concluded that in whatever direction a body moves upon the surface of the earth, there is a force arising from the earth's rotation tending to deflect it to the right in the northern but to the left in the southern hemisphere; and that this deflecting force is exactly the same for motions in all directions, so that if any sensible effects of this sort arise in the case of rivers or of railroads running north or south, the very same effects must take place where they run east or west or in any other direction. The amount of this deflecting force is exactly double of that which is obtained in accordance with the principle adopted by Hadley. An elaborate examination is made of the distribution of temperature over the earth, the most important of the results being that the mean temperature of the whole surface of the earth is 60°·2, the mean for the northern hemisphere being 59°·5, and that for the southern hemisphere 60°·9. With reference to this result Mr. Ferrel remarks that if important data collected by Dr. Hann for the extreme southern latitudes had been at hand while he was engaged with the investigation, the results obtained for the mean temperatures of the two hemispheres might have been nearly equal. This result, which is essentially different from the commonly received opinion, has, it is obvious, important bearings on many questions of terrestrial physics. The distribution over the globe of atmospheric pressure is similarly examined with results of great importance in their relations to meteorological theories. The coefficient of the annual inequality of pressure in North America amounts to only about one-third of that of the interior of Asia, from which the important conclusion is drawn that the difference between Asia and America in this respect does not depend so much upon the difference in the extremes of temperature of the two continents, which is inconsiderable, as upon the difference in the extent of the two continents. The annual maximum of barometric pressure for the United States, except the Pacific coast, occurs about December 23, which is about sixteen days earlier than in Europe. In both continents the time is considerably earlier than the time of the minimum of temperature. The distribution of temperature and pressure and the prevailing normal winds of the globe are shown on seven well-executed maps. In succeeding papers Mr. Ferrel intends to investigate those disturbances in the distribution of temperature and humidity which are of a comparatively local character, and which result in the locally developed phenomena of cyclones and other storms; and finally to apply the principles of atmospheric mechanics thus developed to the explication of oceanic currents.

CLIMATE OF INDIA.—We notice in a recent number of the *Isvestia* of the Russian Geographical Society, an interesting paper by M. Wojeikoff, being a sketch of the climate of India according to the recent works of Mr. Blanford, the reports of Mr. Wilson, and some notes taken by the author during his recent visit. M. Wojeikoff describes very clearly the main features of the climate, and accompanies his description by some tables which illustrate the prevailing and characteristic directions of the winds. Besides, by a comparison of the temperatures of some places in India and South America, situated the one in parts devoid of forests, and the others in places where the forests are yet preserved, M. Wojeikoff shows what a great influence forests have on climate, and he arrives at the conclusion that the absence of great heats and a continuous humidity of air are always met with at those places which, however far from sea, are situated in forest lands. He concludes, therefore, as to the importance of preserving the forests in India, and expects that detailed observations would yet more show their importance as well as the beneficent influence of the irrigation on climate.

LOW BAROMETRIC READING IN THE HEBRIDES, NOVEMBER 11, 1877.—We have received from Mr. Buchan, Scottish Meteorological Society, a communication on this subject. The following readings of the barometer, reduced to 32° and sea-level, were made by Mr. Youngclause, the Society's observer, at Monach Lighthouse (57° 31′ N. lat., 7° 42′ W. long.), on November 11, at 9 A.M., 28·330; 11 A.M., 28·120; 12.43 P.M., 28·008; 1.30 P.M., 27·912; 4.20 P.M., 27·861; 8 P.M. and 9 P.M., 27·752; and at 9 A.M. of the 12th, 27·968; and at 12·43 P.M., 28·038 inches. Thus for nearly twenty-four hours the barometer at this place was under 28·000 inches, and fell to 27·752 inches, the observer remarking that the rise which followed proceeded at a very slow rate.

At Monach, on November 15, at 12.43 P.M., the barometer was 29·703; 9 P.M., 29·051; 11 P.M., 28·807 inches; after which it began to rise, and at 9 A.M. of the following morning it had risen to 29·828 inches, a fluctuation of nearly two inches having taken place during the twenty hours ending 9 A.M. of the 16th. The storm accompanying this depression of the barometer rose at 10.30 P.M., about the time of lowest pressure to the force of a true hurricane, the worst the observer had ever seen during his twenty years' service as a lightkeeper. At the same dates, at Thorshavn, Farö, the readings of the barometer were—lowest at midnight of the 11th, 28·119 inches; 15th, at 9 A.M., 29·002 inches, and at 9 P.M., 29·350 inches, the barometer thus rising a third of an inch in Farö during the time that it fell about an inch in the outer Hebrides, accompanied by a storm of extraordinary violence, being the heaviest storm experienced in the north-west of Scotland generally for very many years.

CUMULATIVE TEMPERATURES.—To simplify the difficulty of obtaining sums of temperature (a highly important climatological factor, particularly in its application to agriculture) for any district, from the ordinary instruments, M. von Sterneck has recently proposed to obtain these indirectly by observation of the sums of actions produced by the temperature. A suitable apparatus for this we have in the pendulum-clock. The course of this represents the sums of the heat-changes, since it represents the sum of the changes of length of the pendulum, produced by different temperatures, which changes cause variations in the time of oscillation. As the laws of pendulum vibrations and the expansion of substances through heat are known, the true sums of temperature can be deduced from the going of the clock. While the watch-maker is concerned to obtain as uniform working as possible, and uses arrangements to compensate the changes in length of the pendulum, the present case requires that these changes should be brought into prominence; so the pendulum is made of some substance (like zinc) which expands greatly through heat. The clock will reveal the variations of temperature by its slowness or fastness, and by comparing its indications, at certain times, with those of a uniformly-going clock, the sum of divergences of the temperature from any given temperature will be ascertained. The principle of this method can also be applied (as the author shows) to determine the variations in atmospheric pressure and in the intensity of magnetism.

GEOGRAPHICAL NOTES

BRAZIL.—Mr. Herbert H. Smith has returned to Baltimore, U.S., after an absence of several years employed in scientific explorations in Brazil. Leaving the United States in January, 1874, for Pará, he ascended the Amazon to Santarem, where he was engaged for two years in collecting and studying the insect fauna of that region. Subsequently he extended his explorations to the north side of the Amazon and on the tributary rivers, as far as the base of the great northern table-land. A collection of insects made by him during this period amounted to 12,000 species, with 100,000 specimens, accompanied by copious notes on the habits, geographical distribution, &c. During 1876 and the early part of 1877 he was connected with the Brazilian Geological Commission in examining the geological structure of the country. He succeeded in making a section of the Devonian rocks of the Amazon region, and discovered a rich carboniferous bed on the north side of the Amazon, in the vicinity of Alenguer. The results of this labour are in the course of publication by Prof. Harrt, of the Geological Survey. Several months of his absence were spent in the southern part of Brazil, near Rio de Janeiro and Minas. Mr. Smith has been able to make some interesting inferences in regard to the geological distribution of Brazilian animals. Bates and Wallace have pointed out that the Amazon forms a limit to the migration of many animals. Mr. Smith is of the opinion that the flood plains of the valley, which average forty miles in width, constitute a far more effectual barrier than a body of water of the same breadth. Birds and insects of powerful flight pass this distance without difficulty, and are generally found on both sides; but the sluggish species, especially the wingless forms, like spiders, are generally confined to one side or the other. This is especially shown in those hymenopterous species in which the females are wingless, as the mutillarias, pezomactri, &c. Here the distinction between the northern and southern groups is very striking. The broad alluvial belt through which the Amazon flows constitutes a very distinct zoological province, in which many of the forms appear to have been derived from those of the high land. The contributions of Mr. Smith to geographical knowledge have not been inconsiderable. His maps of the physical geography of the Lower Amazon and of three important tributaries, the Curna, the Mæcurú, and the Jaurucú, are especially noteworthy. The last-mentioned has been entirely lost sight of by modern geographers, though referred to by earlier travellers. This enters the delta of the Xingú close to the Amazon, and is apparently navigable for steamers to a distance of 150 miles from its mouth. Mr. Smith returns to the United States for the purpose of making arrangements for continuing his explorations for several years longer, so as to accumulate a sufficient body of facts to work out satisfactorily the entire problem of the derivation and the geographical distribution of the insects of Brazil.

AFRICA.—Herr Schütt, who has been despatched by the Deutsche afrikanische Gesellschaft to equatorial Africa, has safely arrived in San Paul de Loando, and starts at once for the interior to complete the work of exploration commenced by Eduard Mohr, whose untimely fate we lately recorded. The series of geographical lectures in Berlin, delivered under the auspices of the Afrikanische Gesellschaft, was opened on January 23, by Dr. Nachtigal, who gave a graphic description of the African kingdom Darfur, which was conquered in 1874 by the Egyptians.

ARCTIC EXPLORATION.—We learn from *L'Explorateur* that Mr. Gordon Bennett, of the *New York Herald*, intends to equip an expedition for polar exploration.

THE ANGARA.—At its last meeting, February 5, the Section of Physical Geography of the Russian Geographical Society discussed the question of the expedition to be sent for the exploration of the Angara and of the water-divide between the Obi and Yenisei rivers, where, it is expected, a water communication could be established between the two main rivers of Siberia. An elaborate report was read, being a sketch of the present state of our knowledge of these tracts, and of the recent explorations of the water-divide; the route the expedition will have to follow was also discussed.

AN AZIMUTH INSTRUMENT.—Capt. Mouchez has presented to the Geographical Society of Paris a portable instrument for taking azimuths and altitudes in travelling. The weight is only a few pounds, and the experiments made at Montsouris show that the latitude can be taken with an error of a few minutes. This instrument is to be used by some travellers that the Paris Geographical Society is sending out to Africa. A single man can carry the apparatus and use it without losing much time. A complete observation requires less than a quarter of an hour.

NOTES

AT the meeting of the Linnean Society on Thursday last, it was unanimously resolved to send a congratulatory letter to von Siebold on the occasion of his jubilee. This graceful act, however, brings into prominence the neglect of the Society to take

any notice of the Linnean centenary, the celebration of which in Sweden, Holland, and Germany, were recently noticed in our columns. Of course the excuse may be urged with some force that such formalities are foreign to English habits, but perhaps an exception might have been allowed in the case of a Society which bears the name and jealously guards the collections, books, and manuscripts of the great naturalist. Perhaps, however, another reason may be found in the fact that the constitution of the Society places the initiative in every case in the hands of the officers whose tenure of office is practically indefinite, and who not very accessible to any impulses of enthusiasm from the general body of the Society even if there were any permissible way by which expression could be given to them. Some disquieting rumours as to the present condition of the Society's business affairs, coupled with its rather troubled history during the past few years, seem to point to the desirability of some changes in its mode of government which would bring the executive into closer relation with the general body of Fellows.

WE gave last week a list of the grants just made from the research fund of the Chemical Society; we are glad to state that since making these grants the fund has been increased by the following donations and subscriptions from the "Alkali Manufacturers' Association." The donations, amounting to 229*l*., are from Messrs. Charles Tennant and Co., 45*l*.; Messrs. J. and L. Pattinson and Co., 35*l*.; Messrs. R. Bealey and Co., 15*l*.; Messrs. Roberts, Dale and Co., 5*l*.; Messrs. James Muspratt and Sons, 35*l*.; Mr. A. G. Kurtz, 50*l*.; Mr. Henry Baxter, 25*l*.; Mr. C. J. Schofield, 5*l*.; Mr. Thomas Walker, 9*l*.; Mr. D. McKechnie, 5*l*. The following are the annual subscriptions to be continued for five years:—Messrs. Gaskell, Deacon, and Co., 11*l*. 14*s*.; Messrs. Chance Brothers and Co., 4*l*.; The Netham Chemical Company, 4*l*.; W. Pilkington and Son, 7*l*.; Mr. James McBryde and Co., 3*l*.; W. Gossage and Son, 4*l*. 10*s*.; Watson, Kipling, and Co., 2*l*. 18*s*.; amounting altogether to 37*l*. 2*s*.

THE President of the Institute of Chemistry of Great Britain and Ireland offers two prizes of 50*l*. each, to be awarded by the Council of the Institute on February 1, 1879, for the two best original investigations involving gas analysis, and conducted by an associate of the Institute. The investigations must have been made within two years of the date of the award, and must not have been published, if at all, more than six months previous to the award. The prizes will not be awarded unless, in the opinion of the Council, the work is of sufficient merit to qualify the candidate for Fellowship of the Institute.

IN his interesting communication on the analogy between chemistry and algebra in our last number, Prof. Sylvester attributes the conception of *valence* or *atomicity* to Kekulé. No doubt the theory in its present developed form owes much both to Kekulé and Cannizaro; indeed, until the latter chemist had placed the atomic weights of the metallic elements upon a consistent basis, the satisfactory development of the doctrine was impossible. The first conception of the theory, however, belongs to Frankland, who first announced it in his paper on Organo-metallic Bodies, read before the Royal Society on June 17, 1852. After referring to the habits of combination of nitrogen, phosphorus, antimony, and arsenic, he says, "It is sufficiently evident, from the examples just given, that such a tendency or law prevails, and that, no matter what the character of the uniting atoms may be, *the combining power of the attracting element*, if I may be allowed the term, *is always satisfied by the same number of these atoms.*" He then proceeds to illustrate this law by the organo-compounds of arsenic, zinc, antimony, tin, and mercury. In conjunction with Kolbe, Frankland was also the first to apply this law to the organic compounds of carbon; their paper on this subject, bearing date December, 1856, having appeared in Liebig's *Annalen* in March, 1857, whilst Kekulé's first memoir, in which he mentions the tetrad functions of carbon, is dated August 15, 1857, and was not published until November 30 in the same year. Kekulé's celebrated paper, however, in which this application of the theory of atomicity to carbon was developed, is dated March 16, 1858, and was published on May 19, 1858. On the other hand, the "chemicographs," or graphic formulæ, which Prof. Sylvester has so successfully applied to algebra, were the invention of Crum Brown, although Frankland has used them to a much greater extent than any other chemist.

AT the General Meeting of the Royal Astronomical Society, on February 8th, the Gold Medal was awarded to Baron Dembowski for his double-star measurements.

WE learn from the *Diario de Campinas* of the death in that town, on December 20, 1877, of Joaquim Corrêa de Mello, a Brazilian botanist, who was well known as a correspondent to many scientific men in the Old World.

THE Rev. Andrew Bloxam, M.A., rector of Harborough Magna, Rugby, formerly incumbent of Twycross, Leicestershire, died on February 2, aged 76. He was well known to British botanists, especially as a diligent student of brambles and roses.

A SUBSCRIPTION has been opened at Paris with the view to erect a monument to the late M. Raspail.

AMONG the exports of Corsica it is said that there are annually between 350,000 and 400,000 blackbirds (*merles*) which are sent to this continent. They visit Corsica in vast numbers each winter to feed on the berries of the myrtle and arbutus with which the mountains are covered. In the month of December they become very fat, and the flavour and perfume given to their flesh by their food cause them to be much esteemed by the *gourmets* of Paris. *A pâté de foie de merle* is a great delicacy.

MR. FRANCIS DAY writes that in our notice of Dr. Bleeker last week, seven volumes of his "Atlas" are said to have appeared, whereas the first part of volume 9 has been issued to subscribers, and the second part will be shortly. The number of volumes which the work was intended to fill was twelve, the whole of the MSS. for which has been left complete, as well as most of the figures, and we may hope that they may yet be published.

WE are glad to learn that Prof. Abich is preparing a complete edition of his numerous and well-known works on the Caucasus, under the title of "Forschungen in Kaukasus-Ländern." The first fascicule will contain a new paper on the coal-measures of the middle parts of the Araxus valley, with numerous plates; and the second, a description of the Trialet mountain-range and of its volcanic rocks and mineral waters, with a geological map on a large scale.

PROF. LEUCKART has just issued, in Berlin, the first part of his "Bericht über die wissenschaftlichen Leistungen in der Naturgeschichte der niederen Thiere" for 1872–75, the continuation of the reviews which he has hitherto been accustomed to compile at intervals in this department of zoology.

THE Société Centrale d'Apiculture et d'Insectologie has had constructed a pavilion in the Champ de Mars for the purpose of exhibiting in 1878, in the most complete manner, everything relating to the education of useful insects, especially bees, and the means of preservation of all kinds against noxious insects.

QUITE recently we had a band of Nubians in London; a small band of Eskimo are at present encamped in Paris, and now, we hear, that shortly Europe will have an opportunity of viewing a group of Aborigines from the opposite side of America. A number of Tierra del Fuegans are to b brought to Brussels,

where they will be installed in the Zoological Gardens. The enterprising authorities of the Paris Zoological Gardens contemplate, moreover, importing some specimens of North American Indians, their plan evidently being to keep up a kind of anthropological review of the various civilised and semi-civilised peoples of the globe.

THE German War Department has recently carried out some experiments on a large scale with the electric light at Metz, in order to test its practicability for military purposes. One of the largest known electric lanterns was used for the trials, and it was found possible to distinguish small detachments out of rifle-shot with sufficient accuracy to direct on them artillery fire.

THE alarming rapidity with which shortsightedness is increasing among German students formed the subject of a recent debate in the Prussian Parliament. From extended observations made in the gymnasia, it appears that the number of the shortsighted increases from twenty-three per cent. in the first year to seventy-five per cent. in the ninth or last year. The too-frequent custom in Germany of forcing lads to study during the evenings with insufficient light, in ill-ventilated rooms, is undoubtedly a main cause of this widespread evil.

"HEROES of South African Discovery," by M. D'Anvers, that we referred to in our last number, will be published, we understand, next week by Messrs. Marcus Ward and Co. This volume will contain an account of Stanley's expedition, and the accompanying map will show the route taken by that discoverer.

THE Société d'Hygiene of Paris is making arrangements to establish, in the cities and towns of France, chemical laboratories for the purpose of examining articles of food and detecting adulterations or unhealthful constituents. In this respect France is, like Germany, following the example of England, where the value of public analysts has long since been satisfactorily demonstrated.

WHILE of course the thermo-electric pile is the most useful measuring apparatus in investigations on radiant heat, it is possible, M. Violle suggests (*Journal de Physique*) to repeat easily all fundamental experiments with the radiometer; by moving it along the spectrum one may readily show (even with the Drummond light) the distribution of the heat in the luminous part and in the infra-red region. The action of coloured glasses, the absorption of heat by water, in layers of different thickness, and all similar phenomena, can be shown without any difficulty. The beam of light employed falls directly, or after passage through the absorbent substance, on the radiometer, the image of which is, by means of a lens, thrown on a screen. The experiment is very distinct and pretty; it may be rendered more precise by adopting an arrangement for counting the number of turns of the radiometer. M. Violle says he has had constructed by M. Alvergniat a small radiometer for the purpose; it is placed on a Duboscq projection apparatus; and the turns can be easily counted on the screen.

IN order to determine the ratio of the specific heats of air at constant pressure and constant volume (a value so important for the doctrine of heat), M. Kayser has recently made fresh experiments on the velocity of sound in tubes. He adopted Kundt's method; in tubes of different diameter, air waves were produced by means of a transversely vibrating rod, and the length of these was measured by the dust figures remaining on the tube. Five tubes of different width were used, and three different steel rods. The results of the inquiry are these: (1) The velocity of sound in tubes depends on their diameter and on the pitch of the tones, and the retardation of the sound is inversely proportional to the diameter of the tubes, and the square root of the number of vibrations. (2) The velocity of sound in unconfined space is accordingly at any rate greater than in tubes; these experiments showed it to be greater than 331·646 m. (3) The velocity of sound in free space can be calculated from that in tubes when two tubes of different width are used; from these experiments the value obtained for it was 332·5 m. (4) From this the ratio of the specific heats of air at constant volume and constant pressure is inferred to be = 1·4106.

THREE experiments, made with a view to find how weak induced currents in the telephone would still suffice to give distinct perceptions by ear, have lately been described to the Vienna Academy by Prof. Sacher, of Salzberg: 1. The closed circuit of the telephone was, for a length of 20 metres, placed parallel with the insulated wire (cloth and wax) of an ordinary telegraph apparatus. The (Morse) signals were given first by means of six, then three, Smee elements. The induced currents gave a distinctly audible effect in the telephone, so that the messages could be understood. 2. The insulated wire was laid bare at two points 20 metres apart, and the ends of a telephone wire 120 metres long, and equally thick, were connected to it at those points. Only a small portion of the current could have passed through the thin wire in the telephone. Yet the tapping was heard with sufficient clearness to enable one to understand the message. (It is an advantage to use a telephone at each ear.) 3. A telephone wire about 40 metres long was connected with the inner thick wire of an ordinary induction coil, and a second telephone line, about 120 m. long, with the outer thin wire. To Prof. Sacher's surprise it was found possible to communicate through the first to the second telephone, and also (somewhat better, it seemed) in the opposite direction; and this nearly as well as with direct connection. The words were perceived more distinctly when two induction-coils were inserted in the same way. The experiment did not succeed with a Ruhmkorff.

THE improvement of the air-pump, which consisted in dispensing with the flask-like receptacle (with stop-cock) as employed by Otto v. Guericke and Robert Boyle, and introducing the much more convenient plate, is generally attributed to Papin. This is shown by M. Gerland (*Pogg. Ann.*, No. 12, 1878) to be a mistake. In Papin's first paper, "Nouvelles Expériences du Vuide," &c., which appeared in Paris in 1674, and which in 1686 had become rare (the only two copies of it now extant are in possession of the Royal Society, and in the British Museum library), he describes and gives a figure of the machine with which the experiments were made, and says:—"Monsieur Hugens (*sic*) fit faire cette machine, ensuite celle de M. Boyle, et il apporta divers changemens qu'on remarquera en comparant leurs figures." This machine (whose figure M. Gerland reproduces) is the first which has a plate. Additional proof that Huygens has the credit of the device is furnished by a letter of Huygens himself, and the date at which the improvement was introduced is shown to have been 1661.

THE Paris Jardin d'Acclimatation has just received a pair of those peculiar Siberian hares, which are grey in summer and white in winter, for the purpose of studying the effects of a temperate zone on the changes of colour.

THE first telegraph line of the Chinese Empire has recently been established between the arsenal of Tian Tsin and the house of the provincial governor. The constructor was Mr. Betts, the director of the School of Mines of Tian Tsin. Although the line is only some ten kilometres in length yet its construction marks a new epoch in the administration of the Empire. The Great Northern Telegraph Company, in spite of repeated efforts made at Foo Chow, have not succeeded in obtaining the permission of connecting this port with Amoy by a telegraph cable, and after vainly trying for two years have finally given up the idea. The line of Tian Tsin has, however, been constructed by order of the Chinese Government; and the population offered not the least resistance wherever the telegraph poles were erected. A cable

was required for the Pi-ho river, which intersects the line. The apparatus used are Morse's die-writers worked by Leclanché elements. Mr. Betts and some of his assistant pupils have been invited to visit Formosa in order to construct a line on the west coast of this island, viz., between Kee Lung and Tay-wan-foo. It is also proposed to establish another line at Tian Tsin, connecting that city with the capital of the province Paou-ting-foo.

DURING the year 1877 the Parisian press numbered no less than 836 different newspapers and serials (against 754 in 1875). Of these, 51 daily and 14 weekly papers are political, 49 serials are theological (37 Catholic, 10 Protestant, and 2 Israelitic); 66 are dedicated to law, 85 to political economy, 20 to geography, 74 to *belles lettres*; 20 are pedagogic, 52 literary-scientific, 56 artistic, 68 treat of fashions, 77 of technology, 75 of medicine; the contents of 43 are mathematical and natural-scientific, of 22 military, of 31 agricultural. Besides the above there are 16 sporting papers, 13 of various contents, and 4 dedicated to Freemasonry.

MANY alloys of tin and other soft metals hardened by addition of antimony, copper, &c., do not give a clear tone on being struck, but a lead-like, dull one. It has been found by M. Lilliman (*Pol. Notizblatt*) that the power of sounding clearly may be imparted to them, by immersing them for a half to one minute in a paraffin or oil bath, heated to a temperature 5° to 5°·5 below the boiling-point, then taking out and allowing to cool. This does not produce any diminution of density, but a considerable increase of the hardness and rigidity.

THE *Proceedings* of the Bristol Naturalists' Society (vol. ii. part 1, new series) contains as usual some papers of more than average value. There are three papers on the microscope by Dr. Fripp, two on the Bristol coalfield by Mr. W. W. Stoddart, besides other two geological papers by the same author, a paper by Mr. W. Evans on the scientific aspects of tanning, and other matters of importance. The *Transactions* of the Bedfordshire Natural History Society for 1876–7 contains a number of good papers on local natural history.

THE gasworks at the Grasbrook at Hamburg have recently been covered with a gigantic iron roof, constructed by the "Essener Union." Its weight is 51,500 kilogrammes, its length 84 metres. With the exception of the roof on the Liverpool gasworks, it is the largest in Europe.

AT the meeting of the Royal Academy of Sciences at Berlin, on January 24, Prof. Du Bois Reymond, as President of the Committee of the Humboldt Institution for Naturalists and Travellers, read a detailed report of the activity of this institution during the past year. The first undertaking was that of Herr J. M. Hildebrandt, and referred to the exploration of the snow-clad mountains of Equatorial Africa, viz., of the Mt. Kenia and of the Kilima-Ndjaro. The well-known traveller, although he approached the former mountain to within a few days' march, could not reach it altogether on account of the unconquerable difficulties placed in his way by the enmity of the native tribes, but he will again take up his plan after having recruited his health at home. Herr Hildebrandt, however, has brought home rich scientific collections from his journey, and has presented them to the scientific societies at Berlin; his geological collections are of special interest. The second traveller sent out by the Humboldt Institution, Dr. Karl Sachs, continued and terminated his investigations on the electric eels (*Gymnotus electricus*) at Calabozo, an important town in the Llanos of Venezuela. He succeeded in adding to our knowledge of *Gymnotus* considerably, so that of this species now quite as much is known as of *Torpedo*; he failed, however, to throw any light upon the development of *Gymnotus*. Dr. Sachs is now occupied in writing a treatise on this subject, as well as a description of the country and the people of Venezuela and his own experiences while travelling.

IT is very unsatisfactory to hear that the consignment of soles and turbot which left the Southport Aquarium on January 3 for the purpose of stocking the Bay of Massachussetts has turned out almost a total failure, one pair of the former only having arrived at their destination in safety. Prof. Baird, United States Commissioner of Fish and Fisheries, is so anxious to introduce the above-named fishes into American waters that another journey to England is contemplated about May next. Much experience has been gained in the transit of live fish across the Atlantic, which will be of considerable importance in facilitating future arrangements. It is highly probable that the bony pike and other American fishes, many of which are remarkable for their brilliancy of colour, will ere long find a home in English aquaria.

THE additions to the Zoological Society's Gardens during the past week include a Common Swan (*Cygnus olor*) from Holland, presented by Mr. John Colam, F.Z.S.; two Crested Guinea Fowls (*Numida cristata*) from West Africa, presented by Mr. Collingwood; two Canadian Geese (*Bernicla canadensis*) from North America, presented by Mr. Edward J. Philpot; four Reeves's Terrapins (*Clemmys reevesi*) from China, presented by Mr. A. Thomson; a Brazilian Tortoise (*Testudo tabulata*) from Cartagena, presented by Capt. King; a Poitou Donkey (*Asinus vulgaris*) from the south of France, deposited; an Azara's Fox (*Canis azaræ*) from South America, purchased.

D'ARREST'S SPECTROSCOPICAL RESEARCHES

WHEN the late Prof. d'Arrest was called to superintend the building of the new observatory in Copenhagen and the erection of a large refractor (16 feet focal length by 11 inches aperture), he took advantage of the opportunity thus offered to enter into more extensive researches on the nebulæ, than he had been able to undertake at Leipzig. He intended at first to observe all the nebulæ which were visible in his refractor, but he soon found that a work beyond human power, and that in fact the nebulæ are infinite in number. Working hard for six years he was only able to collect the eighth part of the observations required for laying down approximate positions of all those nebulæ which are distinctly visible in the Copenhagen refractor, and whose places could be exactly determined. These observations were published as "Siderum nebulosorum observationes Havnienses," in 1867, for which the gold medal of the Royal Astronomical Society was awarded to him in 1875. Prof. d'Arrest died eight years after the publication of his great work, his health broken down by constant night-watches. These years were spent mostly on spectroscopical researches, which were partly published in the *Astronomische Nachrichten*, partly in a separate paper, "Undersögelser over de nebulose Stjerner i Henseende til deres spectralanalytiske Egenskaber," in 1872. This latter paper does not appear to be so widely known as it deserves, and an abstract in the columns of NATURE might therefore be acceptable to many.

It took D'Arrest several years to get sufficiently acquainted with the use of the new apparatus—so different from those usually handled by astronomers of the old school. Various forms of spectroscopes are employed according to the subject to be examined. To observe the protuberances or their lines the greatest possible dispersion is required in order to weaken on one hand the sun's light, and on the other hand the diffuse atmospherical light which forms the background on which the lines are projected; while prisms of small dispersive power are employed when for instance the bright lines of comets or nebulæ are examined. D'Arrest's spectroscope was not intended for any extreme application; it was a so-called Janssen's, after Amici's principle composed *à vision directe* of three crown and two flint-glass prisms from Merz.

The solar light has lately been made to go twice through the system of prisms, and the dispersive power thus doubled has rendered many more bright lines visible than were known

heretofore. Besides the principal lines C, D_3, and F, discovered in 1868, only three or four feeble secondary lines of unusual occurrence were known in the spectrum of the sun's chromosphere, until Prof. Young, in the autumn of 1871, succeeded in raising the number of the visible bright lines to 103 in the course of only four weeks by the above method. These lines are almost uniformly distributed over the whole spectrum from wave-length 706 to 410. The lines are, however, of very varying brightness and frequency. But that artifice is of no good for investigating the planets or planetary nebulæ, for which instruments of the greatest possible amount of light are required.

D'Arrest did not make any profound study of the SUN'S protuberances, but convinced himself of most of the many peculiarities that have been discovered since autumn 1868. He mentions especially the pointed extremities of C and D_3, and the broad basis and *fine point* of F. This is explained by a lowering of temperature and density at a distance from the sun's surface, but it is certain that this phenomenon, with its physical consequences, appears with very different intensity by C and by F, from what it does by $H\alpha$ and $H\beta$ of hydrogen. It appears remarkably enough most distinctly by the feeblest of the two. The lines $H\gamma$ and $H\delta$ are in themselves far more insignificant, and their extension no doubt smaller. D_3 is of another unknown origin. He often observed, besides, the oblique position and distortion of the F-line in protuberances, which were evidently produced by violent eruptions, but he never saw distortions so violent that the line shoots branches to both sides, and at last is altogether dilacerated. Lockyer has represented many such cases in vol. xviii. of the *Proceedings* of the Royal Society. Secchi does not mention them in his book on the sun (Paris, 1871), and they have perhaps only been seen by Young besides. As to the explanation, we meet with a difficulty similar to that above; the phenomenon shows itself principally and nearly exclusively in this single line. D'Arrest never noticed such a thing in $H\alpha$. It is explained by the rapidly rotating mass of hydrogen towards or from the slit of the spectroscope, the wave-length of the light being thus alternately lessened and increased. He calculated a velocity of fifty or sixty geographical miles in the second from the greatest displacement he noticed by the F-line. The direct consideration of the occasional explosive alterations of protuberances leads to similar conclusions. It is beyond doubt that the velocity is so enormous. Much smaller displacements could besides hardly be ascertained by means of the spectroscope.

The spectra of the *sun-spots* have been examined ably by different investigators, and a rich material exists which shows the most probable assumption to be that the sun-spots are the results of cooling. It is in fair accordance with this, interpretation that the increased absorption of light which the spot-spectrum shows by augmentation of the lines in breadth and darkness is considered a proof of the condensation of the gases, to whose absorption the dark lines in the normal sun-spectrum owe their origin. According to d'Arrest's opinion, this pervading *élargissement* must be mainly attributed to the circumstance that the lines are seen on a darker background where the irradiation is greatly lessened, and he believes that the whole theory, which is founded on the supposition of elective absorption of the spots is not quite to be trusted as yet. He never saw bright lines in any spot-spectrum, and mentions that other assiduous observers have likewise failed in this respect. The normal dark lines in the sun-spectrum are of very different degrees of darkness and breadth; some exhibit sharp borders, while others are winged, &c. These intrinsic relations he remarked did not change in the spot-spectra from what they were in the neighbouring region. He found, for instance D_2 to enlarge more than D_1 in proportion to their different breadths in the normal spectrum. From the lessened irradiation, moreover, some sharp lines of the normal-spectrum may become somewhat foggy in the spot-spectrum, as Secchi (*Compt. Rend.* 1869, p. 520) states is the case with the principal lines of sodium, a circumstance which, however, d'Arrest did not confirm any more than the remark by the same astronomer that the lines of magnesium are hardly enlarged in the spot-spectrum. Lockyer says (*Proceedings*, Royal Society, vol. xvii. p. 352) that they are thicker when observed in a spot than usual. Vogel has remarked a similar thickening of easily visible dark lines in Jupiter's spectrum in those parts of the spectrum which correspond to the dark bands on the planetary disk.

D'Arrest does not consider his observations as sufficient to establish anything as to the encroachment of the gas lines in the spot-spectra which occasionally has been observed by the so-called light-bridges in the interior of the spots; he remarks that a similar phenomenon may be produced spontaneously by looking at the image of one of the gas-lines of the protuberances, when the slit is not placed exactly in accordance to the refrangibility of this particular line, and investigators may not have been sufficiently attentive to this circumstance. The light concentrated in the few protuberance-lines is of course stronger than the light of the continuous spectrum of the border, and when the slit is even very slightly displaced the protuberances appear distinctly to reach within it. The same is the case with protuberances inside on the disc of the sun, where they mainly betray themselves by partial reversal of some lines from dark to bright.

The whole of astronomical spectrum analysis is founded upon the law that the source of the light of a continuous (with or without dark lines) spectrum containing rays of every refrangibility, is a solid or fluid substance, and that the source is a glowing gas whenever the spectrum is discontinuous and reduced to separate bright lines. This must within certain limits of pressure be considered as raised beyond doubt, although most skilful chemists disagree as to the nature of spectra of different orders. Plücker and Wüllner state that the same substance gives different spectra at different pressures and temperatures. Dubrunfaut, Reitlinger, and, above all, Angström deny this. The special use which has been made of Geissler's tubes in astronomical observatories is at any rate rather doubtful, since chemists have shown the true nature of the compound spectra which such tubes may furnish—for instance of hydrogen and nitrogen.

Dr. Huggins examined for the first time on August 29, 1864, one of the brightest planetary nebulæ (H., iv. 37) and found the spectrum concentrated in three short bright lines. This discovery proved the nebula to consist of glowing gas under a feeble pressure. Thus also for the first time was obtained the means of distinguishing between true nebulæ and conglomerations of stars. The latter, by far the most common, show the continuous spectrum, the former the linear. This question would hardly ever have been definitely answered by aid of any telescope. First Huggins, then Rosse and Secchi examined almost all those nebulæ in the northern sky, which were visible in their apparatus, and only one or two observers have since made further investigations on the single objects. Capt. J. Herschel examined (1868) in India the southern nebulæ spectroscopically. Most gaseous nebulæ are planetary. D'Arrest had already in his smaller catalogue in 1855 remarked about H. iv. 18: "bluish quiet light, as all planetary nebulæ seen by me show it," and in 1866 in "Obs. Havn." about H. iv. 37:—"Unica prope inter nebulas et prorsus singularis. Ellipsis est egregie cærulea cet." We now know both these to be gaseous nebulæ, analysis showing the light concentrated into three lines near each other in the green and blue regions of the spectrum.

The exact determination of the place of the lines in the normal spectrum was connected with great difficulties on account of their feeble light. It was therefore at first uncertain whether the three lines were identical in the different spectra, but there can now be no doubt as to this, and d'Arrest found by a discussion of the observations of Capt. Herschel, Secchi, and especially Vogel the following wave-lengths for the lines. The line Neb. (3) has by Huggins and Miller, Secchi, and lately Vogel, been proved to coincide with the F-line ($H\beta$) and d'Arrest assumes in consequence its wave-length after Angström :—

	Wave-length.	Vibrations in 1 second.
Neb. (1) ...	500·40 mill. millim. ...	596·64 billions.
Neb. (2) ...	495·66 „ „ ...	602·35 „
Neb. (3) ...	486·06 „ „ ...	614·25 „

Beyond Neb. (3) is occasionally (by H. iv. 18 and the Orion nebula) perceived a fourth line $H\gamma$, but it is very difficult to see it.

The spectra of the different objects are, however, very unlike each other on account of the different *intensity* of the bright lines. There is even occasion to presume that the *mixed gas spectra* do not ever continue unchanged with regard to the relative intensity of the lines, which is very likely, as the relative brilliancy of both the green lines of glowing H and N depends upon the mixture of the gases.

We know that air when under a feeble pressure heated by an induction-current, exhibits the line Neb. (1); it belongs to *nitrogen*.[1] Lockyer and Frankland (*Proceedings*, Royal Society, vol. xvii. p. 454) have shown that the in reality very complicated spectrum of nitrogen, under certain circumstances of pressure and temperature, is reduced to this bright line with but feeble traces of the

[1] D'Arrest mentions that the above wave-length agrees perfectly with Huggins's observation, when he identifies Neb. (1), not with the middle of the double line, but with the least refrangible of the two.

others. It is, besides, the brightest of them all. Extensive investigations published on this subject cannot, however, be said fully to elucidate the question why the other lines of nitrogen do not appear in the spectrum, nor do physicists agree as to the temperature and density which, under these circumstances, must be supposed in the nebulæ. It is, besides, precarious to draw from phenomena observed in Geissler's tubes conclusions as to circumstances prevailing in the vast nebulæ (Zöllner, *Berichte der k. sachsischen Gesellschaft d. Wissensch*, for 1870, p. 254). It appears less important that nobody has been able to comply with Angström's demand when he says ("Recherches sur le Spectre solaire," p. 37):—"This line is double. . . . It appears, therefore, that we ought to be able to show this duplicity in the corresponding line of the nebular spectrum." To their separation is required too narrow a slit for the feeble light of the nebulæ. All considered, nitrogen is at present very likely one of the constituents of nebulæ.

The origin of *Neb.* (2) is not known. The idea at first occurred to Huggins of one of the many barium-lines, but he soon gave this idea up. One of the iron lines holds exactly its place; it is a dark line, but not one of the principal of the rich spectrum; of course this coincidence is accidental. This line is again met with in the spectrum of many red and variable stars. The measures of Vogel (*Ber. d. k. sachs. Gesellsch. d. Wissensch.*, 1871, December 17) agree well enough with the gaseous line when the great difficulties of the cases are taken into account. *Neb.* (2) does *not* occur in the spectra of comets.

Neb. (3) is identical with the line $H\beta$ of hydrogen, whose existence in gaseous nebulæ was proved when Huggins discovered Neb. (4), which is $H\gamma$, that was so long sought for in vain. Hydrogen is everywhere found as one of the constituents of the heavenly bodies, but the comets contain no traces of it. The hydrogen-lines appear even in the spectra of many fixed stars, at least through $H\alpha$ and $H\beta$, but sometimes $H\beta$ and $H\gamma$ are the strongest (β Lyræ), and three hydrogen lines are distinctly seen in the spectra of α Aquilæ and α Lyræ.

D'Arrest then gives in his paper a list of all the nebulæ which have been spectroscopically examined by himself or others.

He speaks first of the gaseous nebulæ, of which H. iv. 37 is the most remarkable; then he mentions those whose spectra are continuous, and thus proved to be mere conglomerates of stars. The latter are by far the most difficult to examine, the feeble light being distributed over a large space, and generally minima visibilia. An astronomer well versed in the use of the spectroscope is, however, often able to decide whether the spectrum is continuous, even if it be not visible by glimpses. Already the absence of the spectrum may occasionally hint about the true nature of the body. He estimates the number of nebulæ known in the middle of 1872 to be about 6,000; of these 150 have been examined with the spectroscope. It is, therefore, only the fortieth part, which is bright enough to be seen through the system of prisms. Although it is hardly possible to draw conclusions from so small a fraction of the whole, still d'Arrest thinks it possible, on account of the critical revision he has given the observations, to arrive by induction at a few results. He finds that of a given number of nebulæ about a fourth give the discontinuous spectrum, while three-fourths give the continuous.

Gas nebulæ are, with but few exceptions, known by their green-blue light, their sharply-defined, round, or elliptic discs with annular bright condensations inside. There are, however, large, extensive, irregular, and complicated nebulæ, which also consist of the three gases, nitrogen ever foremost, though the gases are mixed in different proportions. The very feeble continuous spectrum which appears in many planetary nebulæ can in most cases be shown to arise from the consolidated nucleus, the fluid or solid central mass. The distribution of brightness in extensive nebulosities is very irregular, and the heat in certain regions rises and falls occasionally a little, though no real alterations in the form are known as yet.

The ray-nebulæ are surely mere conglomerations of stars. Those are the long, lenticular nebulæ, often so narrow and fine that such an object may resemble a thin bright line drawn through the nucleus. No such nebula is hitherto known to give a tri-chromatic spectrum.

It was in 1866 that Secchi commenced to examine red stars with remarkable broad bands in the spectra, and he was already, in 1868, compelled to add a fourth class to his three classes of star-spectra. A systematical search after remarkable star-spectra was undertaken in 1873 and following years in Copenhagen. D'Arrest's four papers in *Astronomische Nachrichten* contain only the most remarkable of those he found, and only such as had not previously been mentioned. That most are above the eighth magnitude is evidently only founded on the difficulty of seeing spectra of smaller stars.

The circumstance which Secchi remarked in 1868, that yellow and red colours are so often connected with prominent spectra, seems certainly to be of importance, but the many exceptions should warn us from here expecting any great cosmical law. Neither is their connection with variability a rule without exceptions. There are many strongly coloured stars with very indifferent spectra.

Most of the spectra described are of the third class. These are not uncommon, for when we examine 140 stars we may expect to find one of the third class. They are uniformly distributed over the sky, and found also by white stars. The character of spectra of this class is constant throughout. The positions of the dark bands were also shown by Vogel, in 1872, to be the same for four bright stars. The columns are generally more distinctly separated towards the red end of the spectrum, though the contrary occurs also, and it is even possible to follow the steps from but finely-indicated bands to absolute discontinuity, but the colour has nothing to do with these gradations.

Still more intimately connected with orange colour is the fourth class, and specimens of this class are, in consequence, very uncommon. D'Arrest ascertained that the dark bands in the star-spectra are formed by groups of compressed dark lines against Secchi's experience. He examined spectra of stars with great proper motion, and found, for instance, the spectra of 61 Cygni and 1830 Groomb. to be indifferent, uniform, and continuous. General similarity of the spectra in certain parts of the sky does not exist at all, or has not been proved yet; for instance, it is not true that red and yellow are wanting in the spectra of small stars in Orion. W. D.

THE PROGRESS OF METEOROLOGY[1]

At the opening of his address Dr. Neumayer regretted that the general knowledge and public appreciation of meteorology was still very small in comparison with that of other branches of science. The main object of his address was therefore to induce his hearers to do all in their power to effect a more perfect and detailed understanding of this branch of science among their countrymen in their respective spheres of activity. He treated the subject, and particularly the weather-forecasts, mainly from his own point of view as a naval officer, and pointed out how desirable a greater interest in marine affairs would be in all circles of German home life. The course which meteorology in its application to daily life has taken may be divided into two categories of observations, first the uninterrupted systematic meteorological investigations, and second, the atmospheric disturbances or phenomena governed by the laws of winds, as first described some fifty years ago by Prof. Dove. He then gave a sketch of the progress of meteorology in other countries; of the establishment of the numerous meteorological stations, and the application of telegraphy to this science; of the enormous help afforded by the introduction of rapid means of communication. He pointed out how the greatest progress was made by the United States of North America; that England was second in this respect, and was followed by Holland, France, and Denmark. According to the latest news, the yearly budget for meteorological observations in the United States was raised from 250,000 to 450,000 dollars, apart from all personal expenses. The rise in this sum is explained by the necessity of having special telegraph wires and stations solely for the meteorological service and by the increase in the staff of observers. If in Europe the practical results of observations are not quite as satisfactory as might be desired, it is because the European organisation of the meteorological service is far more imperfect than the American one. The German Government has given its full attention to this important science, particularly with regard to the German navy and the coast population. The poor German fishermen in the Baltic and the German Ocean are already deriving great benefit from the numerous meteorological stations which have been established along the German coast-line, although it is only eighteen months since the service has begun. The German "Seewarte" has been established and now performs its share of international work along with the sister-establishments of England, Holland, and France. Agriculturists will

[1] Meteorology in Daily Life. Address delivered at the meeting of the German Association at Munich, by Dr. G. Neumayer, Director of the Deutsche Seewarte at Hamburg.

derive equal benefit from the meteorological service if inland stations are established and care is taken that the general population of the country are taught how to appreciate their work. Dr. Neumayer concluded with the sentence :—It is not only the duty of the State to found beneficial institutions and to organise them efficiently, it is also the duty of the State-citizen to learn to understand and to appreciate these institutions and to enter into this spirit of the work they are called upon to perform.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

ST. ANDREW'S.—The Senatus Academicus of St. Andrew's University have conferred the degree of LL.D. upon Mr. Henry Woodward, F.R.S., of the British Museum, and Dr. W. C. Macintosh, of Murthly, well known for his researches on British annelides.

THE YORKSHIRE COLLEGE, LEEDS.—Mr. Arnold Lupton, F.G.S., has been elected Instructor of Coal Mining, a department recently endowed by the Drapers' Company of London.

HIGHER EDUCATION OF WOMEN.—A public meeting composed for the most part of ladies, was held on the 6th instant in the Vestry Hall, Kensington, to inaugurate the system of lectures for the higher education of women, undertaken by the Principal and Professors of King's College with the co-operation of the Women's Educational Union. The object of the lectures, which commenced on the 11th instant, is to supplement and continue school education, and the instruction will have, as far as possible, reference to the examinations open to women in the University of London or elsewhere. The minimum age of students is fixed at 17, except in such cases as receive the special sanction of the committee. The classes will be at present held in the Vestry-hall, High Street, Kensington. The curriculum embraces Holy Scripture and Church history, logic and moral philosophy, modern and ancient history, the English, Latin, French, and German languages and literatures, mathematics, mechanics, and botany. Experimental physics, chemistry, and drawing will also be taught as soon as suitable arrangements can be made. Other classes, if necessary, will also be formed. The fees vary from 10*s*. 6*d*. to 2*l*. 2*s*. per term ; for any four complete courses they will 6*l*. 6*s*. For ladies engaged in teaching there will be a remission of 25 per cent.

PRIZES IN BOTANY FOR YOUNG WOMEN.—The Society of Apothecaries of London announce their intention to award prizes to young women students in botany for proficiency in that science, the prizes to be competed for under the following conditions :—The competition will be open to all young women who shall produce from their teachers certificates that their age at the time of examination does not exceed twenty years. The examination will be in general and not medical botany. It will consist of questions both written and oral, in—(1) Structural Botany ; (2) Vegetable Physiology ; (3) Description of Living Plants ; (4) Systematic Botany ; so far as these subjects are contained in Sir Joseph Hooker's "Science Primer—Botany," and in Prof. Oliver's "Lessons in Elementary Botany." The first examination will take place in London on the third Wednesday and the third Friday in June, 1878. Candidates will be required to send their names and their residences, at least fourteen days before the examination, to the Beadle, Apothecaries' Hall, Blackfriars, E.C., when they will receive tickets of admission to the examination.

FRANCE.—M. Bardoux, the French Minister of Public Instruction has taken preliminary steps for organising at Paris on the occasion of the Universal Exhibition, a great congress of schoolmasters. A delegate from each district will be sent by his fellow-teachers. Not less than 4,000 are expected to be present.

M. Bardoux has again taken up in the French Chamber the proposed erection of new schools in France. M. Waddington was the originator of the scheme. It is intended to build no less than 17,320 new school-houses, and purchase, enlarge, or restore 12,000 others.

SCIENTIFIC SERIALS

Verhandlungen der k.k. zoologisch-botanischen Gesellschaft in Wien (vol. i., 1877).—This volume contains the continuations of, and additions to, several important papers commenced in the volumes for previous years. We mention particularly the mycological researches by Herr Schulzer von Müggenburg.—The other papers, of which some are very elaborate, are :—On *Cecidomyidæ*, by Dr. Franz Löw.—On the Diptera genus *Medeterus*, Fischer, by F. Kowarz.—On the fungus flora of Vienna, by W. Voss.—On some spiders from Madagascar, by Count E. Keyserling.—On some American spider genera from the families *Pholcoidæ*, *Scytodoidæ*, and *Dysderoidæ*, by the same.—On the *Holothuria* fauna of the Mediterranean, by Dr. Emil von Marenzeller.—On *Psyllodæ*, by Dr. Franz Löw.—On the *Chalcidiæ* genus *Olinx*, by Dr. Gustav Mayr.—Coleopterum, species novae, by E. Reitter.—On the passage of *Pastor roseus* (Temm.) through Austria, Hungary, and the neighbouring countries in 1875, by V. von Tschusi.—Ornithological notes, by B. P. Hanf.—On the flora of Southern Istria, by I. Freyn.—On the lepidoptera fauna of the Dolomite district, by I. Mann and A. Rogenhofer.—On the coleoptera fauna of Central Africa, by P. V. Gredler.—The volume concludes with an interesting description of the piscicultural establishment of Herr A. Fruwirth at Freiland, near St. Pölten (Lower Austria), by Dr. E. von Marenzeller.

Memorie della Società degli Spettroscopisti Italiani, May, 1877.—A note on the solar eruptions during 1876, by Prof. Tacchini. Number of days of observation, 106; number of eruptions, 9, two on eastern limb and 7 on western limb.—Note by the same author on the present solar phenomena as compared with those during the maximum spot period ; the number of eruptions observed at Palermo in 1871 were 97, while only one was seen in the first four months of this year.—Letter from Father Secchi to Prof. Tacchini on the above subject, also a letter between the same persons relative to Winnecke's comet.—Drawings of solar prominences for January and February, 1876, accompany this number.

June.—Note on a water-prism, by Father Secchi. Path of solar protuberance observed at Rome in April, 1877 ; same for May.—Note by Prof. Tacchini, on a metallic solar eruption seen in June last ; the following lines were visible in the spectrum : b^1, b^2, b^3, b^4, 1474*k*, 4923*A*, 5017*A*, sodium, 5369*A*.

July.—Continuation of the above note.—Note by Prof. Millosevich, on the contact of Mercury with the sun's chromosphere on May 6, 1878.—Drawings of the chromosphere for the months of March, April, and May, 1876, accompany this number.

August.—Note on the zodiacal light, by Prof. Serpieri.—Announcement of the death of Eduardo Heis.—Description of a new form of gravity escapement, by Prof. Young.—The spectroscopic drawings of the chromosphere for June and July, 1876, accompany this number.

September.—A paper on the discovery of oxygen in the sun by photography, and a new theory of the solar spectrum, by Prof. H. Draper. [This discovery, and all matter relating thereto, have already been fully reported in our columns.]—Table of solar protuberances observed at Rome in June, 1877.—Table of solar spots seen at Palermo in July and August, 1877. Four maps, together with a preface by Prof. Heis explaining them ; the maps are of a portion of the heavens adjoining the ecliptic, and show stars down to the fifth magnitude, and they are for use in determining the position of the zodiacal light.

Journal de Physique, January.—On the employment of rotating discs for the study of coloured luminous sensations, by M. Rosentiehl.—On the use of the radiometer as an apparatus of demonstration, by M. Violle.—Rheostatic machine, by M. Planté.—Experimental researches on the interferences of light, by M. Righi.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 10.—"On the Structure and Development of the Skull in the Common Snake (*Tropidonotus natrix*)," by W. K. Parker, F.R.S.

"Observations on the Nervous System of *Aurelia aurita*," by Edward Albert Schäfer, Assistant-Professor of Physiology in University College, London. Communicated by W. Sharpey, M.D., LL.D., F.R.S.

January 24.—The Cortical Lamination of the Motor Area of the Brain," by Bevan Lewis, F.R.M.S., Pathologist and Assist. Med. Officer to the West Riding Asylum, and Henry Clarke, L.R.C.P. Lond., Med. Officer to the West Riding Prison.

Communicated by D. Ferrier, M.A., M.D., F.R.S., Professor of Forensic Medicine, King's College, London.

January 31.—"Further Researches on the Minute Structure of the Thyroid Gland." Preliminary Communication. By E Cresswell Baber, M.B. Lond. Communicated by Dr. Klein, F.R.S.

"On the Limits to the Order and Degree to the Fundamental Invariants of Binary Quantics," by J. J. Sylvester, M.A., LL.D., F.R.S., Professor in the Johns Hopkins University, Baltimore, U.S.

"Remarks connected with the Number of Figures in the Periods of the Reciprocals of Prime Numbers," by William Shanks, communicated by Rev. Dr. Salmon, F.R.S.

Linnean Society, January 17.—Prof. Allman, president, in the chair.—Specimens of Dipterocarpaceæ collected by Signor Beccari, in New Guinea, were exhibited and commented on by Mr. Thiselton Dyer.—Attention was drawn by Mr. E. M. Holmes to a Japanese book containing sections of native woods botanically named in English, Latin, and Japanese.—Several examples of fasciated stems of the Fuller's Teazel (*Dipsacus fullorum*) were exhibited by Mr. J. R. Jackson, who stated these curiously malformed stems were now successfully introduced for the handles of sunshades; he also made remarks on a bird's nest formed of wool and cotton-pod, sent by Sir Bartle Frere to the Kew Museum.—Prof. Owen then read a paper on *Hypsiprymnodon*, a genus indicative of a distinct family in the Diprotodont section of the marsupials. The animal in question is an inhabitant of the Rockingham Bay district, Queensland, and sparingly frequents the dense, damp scrubs bordering the coast. It is diurnal, and feeds on insects, worms, and tuberous roots, or palm berries, holding these in its fore-paws, and sitting on its haunches, after the manner of the phalangers. They breed during the rainy season, February to May. Both sexes have a musky odour, are nearly alike in size, and somewhat over a foot long. This Rat Kangaroo (*H. moschatus*) Mr. Ramsay, of Sydney, first named and gave a short description of, and Prof. Owen now supplements by a fuller account of its skeleton, &c. Besides peculiarities in dentition and skull, the latter dwells on the structural conditions of the hind foot, a modification between that of the Potoroos and Kangaroos. He thereafter enters into comparisons with the feet of the ostrich group (*Struthionidæ*), and speculates on the modifications of the five-toed feet revealed by palæontology, and as applicable to the living marsupials &c. —Mr. Francis Darwin's communication, experiments on the nutrition of *Drosera rotundifolia*, we gave an abstract of in NATURE, vol. xvi. p. 222.—Notes touching recent researches on the Radiolaria, was the title of a paper by Prof. St. G. Mivart. In this *résumé* the history, progress, and present condition of the subject are elucidated. These remarkable marine surface-swimming organisms the author proposes to arrange after the classification adopted by Prof. Haeckel, but considerably modified. The primary groups are reduced from fifteen to seven as follows:—1. Discida; 2. Flagellifera; 3. Entosphorida; 4. Acanthometrida; 5. Polycistina; 6. Collozoa; and 7. Vesiculata.—Mr. J. Kerswill was elected a Fellow of the Society.

Anthropological Institute, January 29.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—Anniversary Meeting. —The president, in the course of his address, alluded to the late conference on the "Antiquity of Man," and expressed his opinion that the question might be discussed with as great advantage from a purely English point of view, as from one embracing a larger area, which to some extent held good with regard to the question as to whether the palæolithic implements of the river-gravel might not be referred to an interglacial period. As to the relics of human workmanship thought to have been discovered in beds of pliocene and even miocene age in Italy, Switzerland, and France, Mr. Evans again on this occasion repeated the words of caution he had previously expressed, but nevertheless believed that eventually traces of man would be found of an earlier date than that which can be assigned either to the cave or river-gravels of Western Europe. These traces were to be rather looked for in the east than in the temperate west or colder north. A strong hope was expressed that Indian geologists would ere long solve in a satisfactory manner the date and origin of the so-called laterite deposits of Madras, but Mr. Evans was able to announce that in Borneo there appeared a chance of some cave explorations being carried on which will probably throw light on the date of man's appearance in that part of the globe. Mr. Everitt, whose experience in cave explorations is well known, has proposed to devote a year to further researches, and Mr. Evans having guaranteed the necessary funds appealed to all those who were interested in the early history of man or in palæontology to assist in raising the by no means inconsiderable amount. The following are the council elected to serve for the ensuing year:—President, John Evans, D.C.L., F.R.S.; Vice-presidents, Prof. George Busk, F.R.S., Hyde Clarke, Major-General A. Lane Fox, F.R.S., Francis Galton, F.R.S., Sir J. Lubbock, Bart., M.P., D.C.L., F.R.S., Prof. Rolleston, M.D., F.R.S.; Directors and Hon. Secs., E. W. Brabrook, F.S.A., W. L. Distant, J. E. Price, F.S.A.; Treasurer, F. G. Hilton Price, F.G.S.; Council, J. Beddoe, M.D., F.R.S., James Bonwick, F.R.G.S., C. H. E. Carmichael, M.A., J. Barnard Davis, M.D., F.R.S., W. Boyd Dawkins, F.R.S., Capt. Harold Dillon, F.S.A., Prof. W. H. Flower, F.R.S., A. W. Franks, M.A., F.R.S., Charles Harrison, F.S.A., J. Park Harrison, M.A., Prof. Huxley, F.R.S., A. L. Lewis, R. Biddulph Martin, F. W. Rudler, F.G.S., C. R. Des Ruffières, F.R.S.L., Lord Arthur Russell, M.P., Rev. Prof. Sayce, M.A., M.R.A.S., E. Burnet Tylor, D.C.L., C. Staniland Wake, M. J. Walhouse, F.R.A.S.

Physical Society, February 2.—Annual General Meeting. —Prof. G. C. Foster, president, in the chair.—The president read the report of the Council for the past year. After pointing with satisfaction to the present condition of the Society, the report goes on to show how it is hoped to extend its usefulness in the future. In addition to a second edition of Prof. Everett's work on the C. G. S. system of units, the Council hopes very shortly to publish Sir Charles Wheatstone's papers in a collected form, and it is making arrangements for the publication, at intervals, of translations of foreign scientific papers, especially such as have had a marked effect on the progress of physical science. A portion of the funds of the Society is to be devoted annually to the formation of a library, and an exchange of publications is already made with various learned societies abroad. Special stress was laid on the distinctive object held in view at the formation of the Society, namely the exhibition, when practicable, of the experiments referred to in papers read at the meetings.—The following officers and council were elected for the ensuing year:—President, Prof. W. G. Adams, M.A., F.R.S.; Vice-presidents (who have filled the office of president), Dr. J. H. Gladstone, F.R.S., and Prof. G. C. Foster, F.R.S.; Vice-presidents, Prof. R. B. Clifton, M.A., F.R.S., W. Spottiswoode, LL.D., F.R.S; W. H. Stone, M.B., F.R.C.P., Sir W. Thomson, LL.D. F.R.S.; Secretaries, Prof. A. W. Reinold, M.A., W. Chandler, Roberts, F.R.S.; Treasurer, Dr. E. Atkinson; Demonstrator, Prof. F. Guthrie, Ph.D., F.R.S.; other Members of Council, Capt. W. de W. Abney, R.E., F.R.S., Prof. W. F. Barrett, F.R.S.E., Major E. R. Festing, R.E., W. Huggins, D.C.L. F.R.S., Prof. A. B. W. Kennedy, C.E., O. J. Lodge, D.Sc., Prof. H. M. McLeod, the Earl of Rosse, D.C.L., F.R.S., Prof. W. C. Unwin, B.Sc., R. Wormell, D.Sc. Prof. H. L. F. Helmholtz and Prof. W. E. Weber were elected Honorary Members of the Society. After votes of thanks had been passed to the Lords of the Committee of Council on Education for the use of the physical lecture room at South Kensington, as well as for the other advantages enjoyed by the Society, and to the several officers of the Society, the meeting was resolved into an ordinary one. The following candidates were elected Members of the Society:— M. T. Cormack, C. J. Faulkner, M.A., E. M. Jones, F.R.A.S., C. Leudesdorf, M.A., and C. E. Walduck.—Prof. S. P. Thompson exhibited a method of showing the lines of force due to two currents of electricity running in parallel directions. A plate of glass is perforated by two holes close together, which are traversed by one and the same wire, and this may be so arranged that the current traverses the parallel lengths in the same or opposite directions. If now the plate be held horizontally while the current passes, and fine iron filings be sprinkled on the plate, they will arrange themselves in the well-known forms. In the plates exhibited the filings had been fixed by gum, so that their arrangement could be exhibited to an audience by projection on a screen.

Chemical Society, February 7.—Dr. Gladstone, president, in the chair.—The following papers were read:—The alkaloids of the aconites, Part II.—On the alkaloids contained in *Aconitum ferox*, by Dr. Wright and Mr. Luff. The alkaloid pseudaconitin from *Aconitum ferox* forms crystallised salts with difficulty. Aconitin, from *A. napellus*, on the other hand, crystallises with facility. When acted upon by saponifying agents,

pseudaconitin is converted into dimethylprotocatechnic acid, and a new base, pseudaconin; mineral acids saponify pseudaconitin; tartaric acid forms the anhydro-derivative apopseudaconitin. With glacial acetic, and benzoic acids an acetyl and a benzoyl derivative are respectively formed. The properties, constitution, &c., of the above substances have been investigated by the authors. The nitrate and the gold salt of pseudaconitin were obtained in the crystalline form.—Notes on the tannins, by Dr. Paul and Mr. Kingzett. The authors conclude that (*a*) the supposition that natural tannin from gall-nuts is a glucoside is doubtful, (*b*) the astringent principle common to cutch and extract of mimosa bark is shown to be a glucoside and to yield on decomposition, unfermentable sugar and a peculiar acid distinct from gallic acid.—On the estimation of phosphorus in iron and steel, by E. Riley. The author has instituted a series of experiments as to the relative value of the molybdate and magnesia processes for determining phosphorus; as a general result, he concludes that the molybdate process always gives results which are too low, and that the magnesia method is the only one to be trusted.—An inquiry into the action of the copper-zinc couple on alkaline oxy-salts, by Dr. Gladstone and Mr. Tribe. The action of the couple on these oxy-salts is of an electrolytic nature; nitrites and ammonia are at first formed, but ammonia is the final product, when nitrates are taken: chlorides are formed, when chlorates are decomposed, but no chlorites or hypochlorites could be detected. When ammonium nitrate is acted on at the boiling-point nitric oxide is evolved.—On a new method for the determination of boiling-points, by H. C. Jones. A glass tube 4 mm. internal diameter and 200 mm. long is bent into a U, so that the one end, which is open, projects 15 mm. beyond the other which is closed. The closed leg is filled completely, and the open leg partly, with mercury, and a bubble of liquid manipulated into the closed end of the U. On immersing the U in a paraffin path and heating the latter, the liquid boils and the temperature at which the levels of the mercury in the two limbs are equal is the uncorrected boiling-point of the liquid.

PARIS

Academy of Sciences, February 4.—M. Fizeau in the chair.—Telegraphic determination of the difference of longitude between Paris and the Observatory of the war depôt at Algiers, by MM. Loewy and Perrier.—Portable instrument for determining itineraries and geographical positions in journeys of exploration on land, by M. Mouchez.—On some applications of elliptic functions (continued), by M. Hermite.—New observations on chemical reactions of the effluve, and on persulphuric acid, by M. Berthelot. When binary compounds are acted on by the effluve one part is decomposed while the other forms more complex combinations. Persulphuric acid, as well as ozone and oxygenated water, is gradually destroyed when the external influence, under which it has appeared, has ceased to act.—On definite hydrates, formed by hydracids, by M. Berthelot.—Experimental researches on the fractures which traverse the earth's crust, particularly those known as joints and faults (continued), by M. Daubrée.—The vibrations of matter and the waves of the ether in phosphorescence and fluorescence, by M. Favé.—Transversal vibrations of liquids, by M. Dubois. He puts a little liquid, with vermilion in it, on the branches of a tuning-fork, or on a paper strip, over the open end of a sounding pipe, and studies the striæ formed in it.—On some results obtained in treatment of phylloxerised vines, by M. Boiteau.—Discovery of a small planet at the Observatory of Toulouse, by M. Perrotin.—Ditto at the Observatory of Marseilles, by M. Cottenot.—Note on some consequences of the theorem of M. Villarceau, by M. Lemoine.—On the employment of the graphic method for prediction of occultations and eclipses, by M. Hatt.—On a new note by M. Boussinesq relating to the theory of elastic plates, by M. Levy.—On the formula $2^n - 1$, by M. Pepin.—On the determinant whose elements are all the possible minors of given order of a given determinant, by M. Picquet.—On the similarity of the photographic *réseau* of the sun and the craters of the moon, by M. Lamey. A similar cause is inferred.—On the equation of Lamé, by M. Brioschi.—On the dark lines of the solar spectrum and the constitution of the sun, by M. Cornu. By arranging in order of quantity the elements volatilised at the sun's surface (from the position and relative brightness of the dark lines), he considers the composition of the absorbent layer to be similar to that of volatilised aerolites.—The elements present in the layer of the sun which produces reversal of the spectral rays, by Mr. N. Lockyer.—On the refraction of gases and vapours, by M. Mascart. The results are given for some substances of mineral chemistry. It is shown, *inter alia*, that refraction furnishes a method for determining divergences from Mariotte's law where direct experiments on changes of volume or measurement of densities are difficult.—On the repulsion resulting from luminous radiation, by Mr. Crookes.—Researches on accidental double refraction, by M. Macé.—New direct vision spectroscope, by M. Thollon. This has a central fixed part and two symmetrical movable systems (consisting of metallic plates connected by joints and having prisms fixed on them) capable of turning about fixed axes parallel to the slit.—On the densities of vapour, by M. Troost. The density of vapour of acetic acid takes its theoretical value, corresponding to four volumes, even at temperatures bordering on 120°, if a weak pressure be operated with.—Dissociation of carbonate of baryta, by M. Isambert.—Memoir on the solubility of lime in water, by M. Lamy. This solubility varies with the nature or origin of the lime, its state of molecular aggregation, the temperature of its preparation, its dehydration or recalcination, its duration of contact with water, and previous heating of the milk of lime.—On anhydrous trichloracetic acid, by M. Clermont.—On the combinations of quercite, by M. Prunier.—On the nature of the very volatile products contained in raw benzines, by MM. Vincent and Delachanal. Besides carburets of hydrogen and coal oils, the authors find ordinary alcohol, cyanide of methyl, and sulphide of carbon.—On the employment of rotatory discs for study of colour sensations (continued); harmony of colours, by M. Rosenstiehl.—On use of the polarising microscope with parallel light for determination of the mineral species contained in thin plates of eruptive rocks, by M. Levy.—On the leadhillite of Matlock, by M. Bertrand.—On a new density apparatus, by M. Pisani.—Experiments demonstrating the *rôle* of air introduced into the arterial and venous systems, by M. Feltz. Air introduced, even in a very small quantity, into the aortic system, works great mischief; introduced into the venous system it is almost without danger.—New researches on the function of mucedineæ and their property of inverting cane-sugar (*à propos* of a note by M. Gayon), by M. Bechamp.—Treatment of cancers of the breast by ischæmia of the mammary gland by means of vulcanised caoutchouc, by M. Bouchut.—Barometric differences between neighbouring stations, by M. Renou.—Remarks on M. Faye's note regarding relations between phenomena of terrestrial magnetism and the rotation of the sun, by M. Broun.—On the telephone, by M. Champvallier. It is possible to correspond telephonically on wires carried on posts which also support wires for ordinary telegraphy to an extent of at least ten kilometres, and probably much further.—On the telephone, by M. Breguet. The effect is improved by placing one or more vibrating plates (perforated at the centre) at about one millimetre in front of the ordinary plate of the telephone.—On the earthquake at Paris on January 28, by M. de Gannes.—On the same, by M. Lefebvre.

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